THE UNIVERSITY
OF ILLINOIS
LIBRARY
625.05
RAL
V.13
REMOTE STORAGE

Railway Electrical Engineer

REMOTE STORAGE
23349
39

December, 1922

INDEX TO VOLUME XIII

1922

PUBLISHED BY

SIMMONS-BOARDMAN PUBLISHING CO.

NEW YORK CHICAGO CLEVELAND WASHINGTON
CINCINNATI LONDON

625.05
RAL
V.13

INDEX, 1922

VOLUME XIII

*Illustrated articles. †Non-illustrated notes. ‡Communications. §Editorials.

522047

*Illustrated articles. †Non-illustrated notes. ‡Communications. §Editorials.

J

K

L

M

N

O

P

Q

R

*Illustrated articles. †Non-illustrated notes. ‡Communications. §Editorials.

S

T

U

V

W

Y

AUTHORS

PERSONALS

Railroad:

Supply Trade:

*Illustrated articles. †Non-illustrated notes. ‡Communications. §Editorials.

Obituary:

*Illustrated articles. †Non-illustrated notes. ‡Communications. §Editorials.

$25.05
RAL

Railway Electrical Engineer

Volume 13 JANUARY, 1922 No. 1

Subscription Rate Lowered

It is with pleasure that the *Railway Electrical Engineer* announces the lowering of its subscription rate from $3 to $2 per year. Although publication costs are still high, we have been able to absorb some of these costs and effect a real saving to our subscribers. The lowered rate will not be reflected by any change in the editorial pages, but on the contrary the *Railway Electrical Engineer* will continue to maintain the high quality of service to its readers that has characterized the publication in the past.

Bearings for Headlight Sets

No standards have been determined for the bearings of locomotive headlight sets, although it would be both desirable and possible to establish them. The subject of anti-friction bearings was introduced by the committee on that subject of the Association of Iron and Steel Electrical Engineers at the annual convention held September, 1921. The report of the committee contains the following: "While the railroads have had a very successful experience with car lighting generators equipped with anti-friction bearing, their experience with headlight generators has not been the same. In the early history of anti-friction bearings applied to motors appear many cases of complete failure, and while this may have been due to misapplication or to improper mounting, these examples must be lived down, before the anti-friction bearing receives a clean bill-of-health."

In order properly to design a ball bearing for any class of service, it is essential for the manufacturer to know under what conditions the bearing is supposed to operate. Operating temperatures play an important part in the design of ball bearings and for this reason it is important to know beforehand where the set is to be placed on the locomotive. When the set is mounted on top of the smokebox ahead of the stack, conditions, particularly in winter weather, are different than when the set is mounted on top of the boiler just ahead of the cab.

In the last report of the committee on locomotive headlights and classification lamps of the American Railroad Association, the following with regard to the location of the headlight set was offered as recommended practice:

"The turbo-generator should be located as near the cab as practicable, preferably set longitudinally with the boiler, on the left-hand side, with generator end toward the locomotive cab and in a position so as not to obstruct the vision of the fireman. Where conditions will not permit location of turbo-generator in this manner, it should be placed on the top of boiler with dynamo end toward side equipped with conduit system (preferably the left side).

Due to the swaying of the locomotive on uneven track and to the gyroscopic action of the armature and turbine running at a high rate of speed, large forces may be set up in the bearings and where it is possible to state beforehand that the set will be mounted with the shaft parallel to the running rail, these forces will be reduced and the manufacturer of bearings will be better able to place locomotive headlight set bearings on the same high standard which has been established for the bearings of car lighting generators. Practically all makes of headlight sets are now equipped with ball bearings and by giving careful attention to such details as these, the looked-for results can be obtained.

The Supervising Engineer

The fact that railroads of today cannot be managed efficiently by old fashioned methods used by old fashioned executives is being clearly demonstrated by the roads that are attempting to do it. The truth is that many railroad problems of today did not exist a score of years ago, or even a decade ago, and in fact there are new problems that are arising almost daily. The unfortunate part of the situation from a financial point of view comes from the fact that many of the most important problems are more or less of a technical nature and that not a few railroad officers are wholly lacking in technical knowledge.

It has been very truly said that a little knowledge is a dangerous thing and it is doubtful if there is any place where this statement is more frequently demonstrated than in the various engineering departments of a railroad. It is true that the basic principles of engineering are very similar, whether they pertain to electrical, mechanical or civil engineering. There is, however, a wide divergence in carrying out the intricate details of any real problem falling naturally into any one of these three branches.

Moreover the importance of any one of the three engineering branches is not so great that it should outrank the others. The civil engineer on the railroad has long maintained an unjustified position of being the only engineering department. A careful analysis of the so-called engineering department will reveal that the problems with which it deals are in no way any greater in magnitude nor any more difficult of solution than those of the other departments. Tradition alone appears

to be the sole reason for dominance on the part of the civil engineer.

In a very similar way the mechanical engineer feels he is more important than his electrical brother, where perhaps they both agree that their work is much more complicated than that of the signal engineer. Unfortunately, the feeling of self-importance reacts in the most wasteful manner. As has been said, the basic principles of engineering are similar and those with technical training often feel qualified to perform certain kinds of work which in reality falls outside of their logical scope. For example, the so-called engineering department is responsible for the supply of water along the right of way.

Frequently, pumps are required to fill tanks and such pumps may be driven by steam, gasoline or electricity. As a general rule, the engineering department is not thoroughly familiar with the characteristics of these various types of power, but there are many instances on record where, rather than consult with the mechanical or electrical men, they have purchased equipment that proved to be totally inadequate, exceedingly inefficient, or that did not conform with existing power facilities.

Much signal practice calls for a knowledge of intricate circuits and a certain signal department felt that it was justified in constructing a long stretch of 3,300-volt signal feeder in underground trunking. The conductors were covered with pitch and apparently the job should have been satisfactory. When the power was turned on the installation was literally shot to pieces. Why? Simply because the supervising officer had allowed the pitch to be poured too hot, thus ruining the installation and scrapping miles of cable with a tremendous financial loss.

The modern railroad should not continue to make such serious economic blunders. If ever there was a time when the roads should be chary of their finances, it is now. It is plainly evident that if such costly mistakes are to be prevented some form of co-ordination between the several engineering departments is greatly needed. Such co-ordination could be secured by having the several engineering departments report to a single man of high calibre understanding in all kinds of engineering matters. With an arrangement of this kind it would be easily possible to remove from the realm of doubtful authority any problem closely approaching the borderline of engineering jurisdiction.

Railroads cannot afford to continue the glaring errors of the past and if supervision of the engineering departments can remedy the situation, let us have the super-engineer with the least possible delay.

Train Control Maintenance

The order recently served upon 49 railroads by the Interstate Commerce Commission requiring the installations of train control equipment on certain portions of their lines brings again to the front the question of maintaining this equipment. Most of the train control systems at present in use are more or less associated with the automatic block signal and for this reason it has been assumed that the train control apparatus should be maintained by the signal department. So far as that part of the equipment which is located along the right of way is concerned, this is perhaps a proper assumption, particularly if connection to signal circuits exists. Some of the train control systems, however, involve considerable electrical equipment on the locomotive and consequently necessitate the attention of a skilled electrician. From the nature of its location it would seem that this equipment could be best looked after by the headlight maintainer. After all he is the man on the job and it should be easily possible for him to broaden his responsibility to include the maintenance of the train control apparatus on the locomotive.

New Books

Diagnosing of Troubles in Electrical Machinery—By Miles Walker. 450 pp., illus., 7 in. x 10 in. Bound in Cloth, Published by Longmans Green & Company, New York, N. Y.

The author of this book has worked with electrical machinery for the past thirty years and during that time has had a large number of troubles in connection with electrical machinery brought to his notice, many of which were difficult to diagnose and correct. In the book he has recorded many of his experiences in logical order for the purpose of assisting others who have to deal with similar problems. The book discusses troubles due to defective insulation, overheating, low efficiency and those peculiar to alternating and direct-current generators and motors, synchronous convertors, motor-generators and induction motors. It deals especially with conditions existing in the field as distinguished from factory tests.

Whittaker's Electrical Engineer's Pocket-Book.—Edited by R. E. Neale. Fourth Edition. London and New York, Sir Isaac Pitman & Sons, Ltd., 1920. 671 pp., illus, 6 x 4 in., cloth.

This edition, the first in nine years, has been entirely rewritten. It scope has been materially extended and the assistance of several specialists secured in order that the treatment of each subject might accord with the latest practice.

The book is intended, while covering the range of matter and having the convenience of reference commonly expected from a pocket-book, also to furnish an up-to-date synopsis of each subject which will have the coherency and wealth of detail usually found only in text-books, so that the volume may be equally useful for systematic reading and for reference. The field covered is broadly that of industrial electrical engineering.

Power House Design.—By Sir John F. C. Snell. Second Edition. London and New York, Longmans, Green & Co., 1921. (Electrical engineering series.) 535 pp., illus., diagrs., tables, 9 x 6 in., cloth.

In preparing this book, the author has drawn upon his own experience of over twenty years and has collected and classified the experience of other engineers. The information thus acquired has been carefully sifted and condensed in the present volume, which the writer believes to contain all the requisite practical information on its subject. The principles and information given cover the design and equipment of central stations and isolated plants for supplying light and power to cities, factories, mines, railroads, etc., and are accompanied by typical examples of modern installations. This edition has been thoroughly revised and to a considerable extent rewritten.

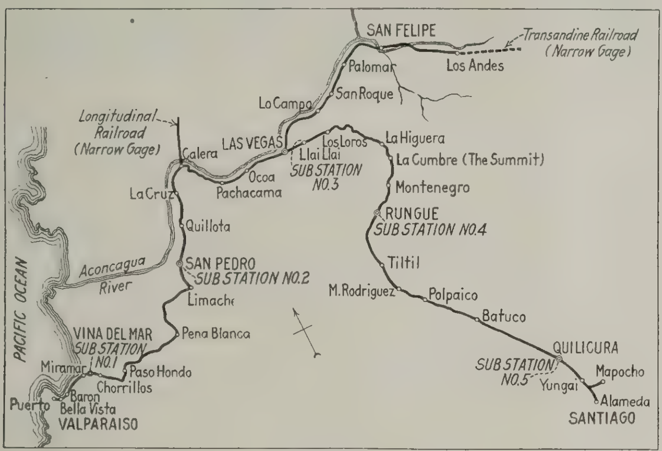
The Chilean Railroad Problem and Its Solution

Electric Operation Will Increase Track Capacity, Lower Operating Costs and Improve Service

By David C. Hershberger
General Engineer, Westinghouse Electric & Manufacturing Company

THE transportation system has a particularly vital influence on the development of Chile, because of the peculiar location of the natural resources of the country. Located between the summit of the Andes and the Pacific Coast, Chile occupies a domain 2,600 miles in length from north to south and varying in width from 60 to 280 miles. While there is considerable coastwise steamer traffic, especially in the northern part, the railroad system is the main artery of transportation serving the central and southern sections of the nation.

It is essential that this system be kept up to the most modern standards in order to serve the country adequately and efficiently. To attain this objective, the government of the Republic of Chile has undertaken the most extensive electrification in progress at this time. This procedure is in strict accordance with the well known progressive policy of our southern neighbor.



Map of Zone Being Electrified

The urgent necessity for electrification was brought to the attention of the government during the World War by the congestion of traffic in the first zone. This zone comprises the section of the line between Valparaiso and Santiago, and the branch from Las Vegas to Los Andes. The Valparaiso-Los Andes section forms a part of the transcontinenal system to Argentina, the Transandine Railroad continuing eastward from Los Andes. During this congestion, which occurred in 1917, the steam locomotives used in this zone were of relatively small capacity, which necessitated the operation of a large number of trains in order to move the freight tonnage and handle the passenger traffic. The lack of adequate motive power caused a congestion of traffic which was rapidly approaching the capacity of the line. It was at one time considered necessary to lay a second track on a considerable portion of the line in addition to that which was already double tracked. The 1917 congestion was relieved to a considerable extent several years ago when 20 Mikado type steam freight locomotives were put in service in the first zone.

Chilean engineers and business men have recognized for many years that the tremendous amount of water power available could be used profitably not only for industrial purposes, but for the operation of the railroad transportation system as well.

In 1918, a commission consisting of Rafael S. Edwards and Ricardo P. Solar, was appointed to prepare a report on the electrification of the broad gage lines which extend from Valparaiso southward to Puerto Montt. These lines are divided into four zones. The first zone has been described, and the others extend southward in numerical order. The commission completed its report covering all four zones in 1918, and the decision to electrify the first zone followed, as a result of the economies and advantages set forth in this report.

The specifications required the bidders to supply not only the electrical equipment, but to execute the construction work as well, and to turn over to the government ready for operation, the complete electrification. These stipulations make it necessary for the bidders to construct the substation buildings and erect the overhead contact lines complete.

The contract for this large undertaking was awarded to Errazuriz, Simpson & Company. This company will execute the construction work while the electrical equipment will be supplied and installed by the Westinghouse Electric International Company. The former company is a well known Chilean firm which has completed important engineering work in Chile. In addition to conducting a large importing and exporting business, this company markets in Chile, the electrical apparatus of the Westinghouse Electric International Company.

Track and Roadway

Mention has already been made of the traffic congestion. Electrification will change the complete status of the railroad as to track capacity, as the flexibility of electric transportation is such as to provide not only the possibility of trebling the traffic of the road, but of going to much greater limits if necessary.

The extensive electrification which has been undertaken comprises a complete steam engine division—a distance of 116 miles between Valparaiso and Santiago, and 28 miles between Las Vegas and Los Andes. From the port of Valparaiso, the railroad skirts the bay of the same name nearly to Miramar, and then passes through Vina de Mar, a famous summer resort and exclusive residence district. After crossing a low coast range the line follows the Aconcagua River to Las Vegas through the fertile valley in the Quillota district. At Calera, the Longitudinal Railroad starts northward to Antofogasta and Iquique, while at Las Vegas the Los Andes branch leaves the main line. Llai Llai, located approximately half way

between Valparaiso and Santiago, is the meeting point for all passenger trains making connections with the Los Andes branch trains. At this point the heavy grade section over the mountain begins, and ends near Batuco on the eastern side of the mountain range.

The curvature, considering the entire line, may be considered to be of medium severity. Starting from Puerto, the line circles the bay to Miramar and has considerable curved track over the low coast range and along the Aconcagua River. The most severe curves are located on the section of the line between Llai Llai and Til Til. The maximum curves are ten degrees and are located near Los Loros. On the eastern slope the maximum curve is 9.5 degrees located near San Ramon. The line between Batuco and Quilicura is practically level tangent track.

The road is double tracked between Valparaiso and Limache, a distance of 27 miles; between Ocoa and Llai Llai, 8 miles; and between Yungai and Mapocho Station, a distance of 1½ miles, making a total distance of 36½ miles of double track line. The track is 5 ft. 6 in. gage, laid on Chilean oak ties and is rock ballasted for practically the entire length of the line in the first zone. Eighty-five pound rails are used between Llai Llai and La Cumbre and between Calera and Ocoa. The rest of the line between Valparaiso and Santiago is laid with 80-pound rails, while the branch to Los Andes is laid with 75-pound rails.

The track is well maintained. Due to the absence of severe cold weather, the sub-grade is not subject to alternate freezing and thawing. This condition contributes to the low track maintenance costs. Furthermore, the wheel loadings will be such that with most of the locomotives, though much more powerful than the steam locomotives being replaced, the duty on the track from static loading will be less than that with the steam locomotives.

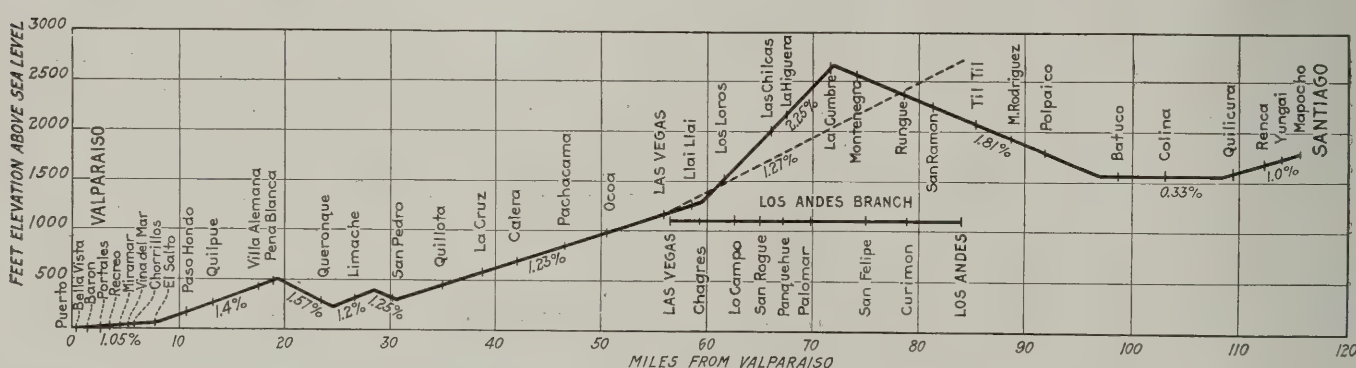
The largest bridge is that over the Vina del Mar River near Valparaiso, known as the Las Cucharas Bridge. This is a steel structure of the cantilever type, 440 feet long and carries two tracks. There are a number of girder type bridges, the longest of which is 250 feet in length.

There are six tunnels on the main line, namely: Los Maquis, Los Loros, Centinela, San Pedro and the two Paso Hondo tunnels, the latter being located on the double track section. San Pedro is 1,600 feet in length, the longest of the six tunnels. The first three tunnels are located on the Tabon or maximum grade section between Llai Llai and La Cumbre. All the tunnels are dry except San Pedro, so that the problem of corrosion of overhead material is not serious. The clearances from rail to roof do not seriously interfere with the design of the overhead material or the locomotives. The smoke conditions in these tunnels are a detriment to providing the best working conditions for the train crews and traveling service to the public. The elimination of these conditions by electric operation constitutes an important improvement in operation.

The grade conditions have always been an obstacle in the way of moving, advantageously, the traffic in the first zone. It has been necessary to maintain several helper sections to handle the freight traffic, while practically all passenger trains require helpers ascending the Tabon grade between Llai Llai and La Cumbre. With electric operation all helper service will be eliminated, except in connection with the freight trains ascending the Tabon grade.

View of the Double Track Section, Looking East from Ocoa

The condensed profile gives a general idea of the grade conditions. The maximum grade, which is 2.25 per cent, is located on the Tabon between Llai Llai and La Cumbre, the summit. This is the most severe grade in the first zone and forms the major part of the twelve-mile grade. The summit has an elevation of 2,600 feet above level of the sea. The maximum grade on the eastern slope is 1.81 per cent and is located near San Ramon. The elevation of Santiago is 1,800 feet so that the most severe hauling conditions are southbound, or toward Santiago.



Condensed Profile of the First Zone of the Chilean State Railway to Be Electrified

To provide for increased traffic under steam operation would require heavier locomotives than those in service at present which would probably necessitate the instal-

lation of heavier rails. This in turn would involve a relatively large expense, and the maintenance expense would increase proportionately.

The change to electric operation permits of increasing the tonnage tremendously without the necessity of changing rails, by reason of lower track stresses, even with engines of greater power than those in service at the present time. The more efficient use of the trackage by electric operation due to being able to handle not only a greater number of trains, but a greater tonnage per train, is an extremely important consideration. For equal tonnage the train maintenance will be less with electric operation than with steam.

Las Cuchuras Bridge Spanning the Vina del Mar River Near El Salto

The Fuel Situation

While it was realized that the problem of traffic congestion could perhaps be solved by the use of larger and more powerful steam locomotives, it was further recognized that steam operation would not solve the fuel problem. This problem has two serious phases; first, the cost of fuel; and second, the partial dependence upon imported coal.

The railroad fuel bill has in the past few years reached excessive figures due to the high price of coal. The price of coal in Chile is governed, not by the price of coal mined in Chile, but by the price of imported coal, much of which in the last few years has come from the United States. To the cost of the coal must be added ocean freight transportation, and lighterage charges, so that before the war the cost varied from $7.00 to $10.00 per ton for imported coal of good quality. During the war it is understood to have risen as high as $25.00 to $28.00 per ton, while more recently the price has ranged from $15.00 to $20.00 per ton.

The price of Chilean coal has been slightly less than these values, but it is readily seen that with the almost unlimited hydro-electric power available, sold at a reasonable rate, the electrification program is not only justified, but is the solution of the fuel problem from the cost standpoint. The further energy economies made possible with electric motive power by the reduction of standby losses in freight, passenger and switching service, and as a result of the energy returned to the line by regenerative electric breaking, are not to be ignored.

The elimination of transportation of fuel for railroad use not only releases this car and locomotive equipment for hauling revenue freight, but will assist in supplying needed rolling stock for the transportation of products of the South. The railroads in the past have been embarrassed seriously at times due to inability to obtain sufficient coal for their operation at times of labor troubles in the Chilean mines, as well as from other causes. At these times it has been necessary to curtail the service with the consequent inconvenience to the traveling and shipping public. By the use of hydro-electric power for transportation, this situation will be entirely relieved and the nation will be wholly self-dependent.

Present and Future Freight Service

The southbound tonnage consists largely of imports such as coal, merchandise, machinery, automobiles, food products, etc. Part of this tonnage results from the coastwise steamer traffic in handling the transfer of products of the nation from one point to another.

The northbound traffic is composed largely of agricultural products such as wheat, corn, rye, potatoes, alfalfa, tobacco, beans, fruits of all kinds, dairy products, wool, wine, live stock, coal, copper and lumber from the great forests of the South. Much of this tonnage is destined for the central and northern sections of Chile, while a considerable part of it is exported to other countries.

The principal exportation in the past has been nitrate of soda and copper. Large quantities of iodine, borax, sulphur, salt and iron ore are also exported.

Freight tonnage southbound from Valparaiso averages approximately 3,600 gross tons daily in normal times, while that passing Las Vegas in the same direction is 3,900 tons. The northbound traffic is only slightly less than that of the southbound.

At present, the freight trains going toward Santiago are made up of 20 to 30 cars each, or a trailing load of 550 tons. These trains are hauled by Mikado type steam locomotives assisted by a Borsig Consolidation between El Salto and Pena Blanca and on the Tabon grade. In the opposite direction a helper locomotive is used between Til Til and Rungue.

Puerto Station, Valparaiso. The Station Building is on the Right

With electric motive power 770 ton trailing loads will be hauled by one locomotive in either direction, except in ascending the Tabon grade a helper will be used. The trailing weights will be increased 40 per cent and the number of trains reduced approximately 28 per cent.

The locomotives employed for this service will weigh 113 tons and have a nominal rating of 1,680 hp. At this rating the speed will be 22.6 miles an hour, with a tractive effort of 27,950 pounds. These engines will be

of the Baldwin-Westinghouse design with 0-6-0 + 0-6-0 wheel arrangement. The two three-axle trucks will be connected by a Mallet hinge and all the buffing strains will be transmitted through the underframing. The maximum speed of these engines will be 40 miles an hour.

Electro-pneumatic control will be used for the control equipment so arranged as to provide for regenerative braking. A motor generator set will supply current for separately exciting the motor fields in regeneration.

Westinghouse EL air brake equipment will be used. It has the straight air feature for control of the engine and automatic air for control of both the locomotive and train. The Westinghouse air brake has been the standard air brake equipment used on the Chilean railroads for many years.

A considerable reduction in running time will be made by the freight trains. Through freight trains that now make the one-way trip in 10 to 12 hours will be capable of going through in 6 to 7 hours. With the faster schedules the crew expense will not only be less, due to the reduction of time on the road, but fewer locomotives will be required to handle the service, on account of the shorter running time. The increasing of the freight train trailing loads alone will result in reducing the number of trains and the crew expense by approximately 28 per cent on the basis of present traffic.

Helpers Will Be Eliminated in Passenger Service

Under normal conditions the express passenger trains carry six to ten cars, or a trailing load of 200 to 300 gross tons in either direction between Valparaiso and Santiago. Occasionally these trains are composed of as many as 16 cars, and helpers are used on the Tabon grade. The express passenger trains are for the accommodation of first and second class passenger traffic and are the fastest trains in the service, making only a few stops in the 116-mile run. The omnibus trains which make all stops between Valparaiso and Santiago are always the most heavily loaded passenger trains in the service and carry cars for the accommodation of first, second and third class passengers.

Express Train at Til Til Drawn by a Baldwin Locomotive

The electric locomotives will be capable of hauling the 300-ton trains in either direction without the aid of helpers on any section of the line. These locomotives will have a nominal rating of 2,250 hp. corresponding to a speed of 37 miles per hour at a tractive effort of 23,400 pounds. They will weigh 127 tons and will have 105 tons on the drivers. The wheel arrangement will be 2-6-0 + 0-6-2, a two-wheeled guiding truck being used at each end of the locomotive.

The two three-axle trucks will be connected at the inner end by a drawbar and spring buffers. These locomotives will be capable of making a maximum speed of 62½ miles per hour. The cabs will be very similar to the freight engine cabs and will carry virtually duplicate control equipment.

Local passenger trains are operated between Valparaiso and Llai Llai and intermediate points. At present many of these trains carry ten cars between Valparaiso and Vina del Mar, while the locomotive ratings provide for a maximum of twelve cars per train. These trains are composed of first, second and third class cars, usually hauled by one locomotive as this section of the line does not have the most severe grade conditions.

East Portals of the Paso Hondo Tunnel

The new motive power for this service will consist of 80-ton double truck locomotives having the inner ends of the trucks connected by a Mallet hinge. The wheel arrangement will be 0-4-0 + 0-4-0. Each of the four axles will be equipped with a direct geared motor the same as the express passenger locomotives. The engine rating will be 1,500 hp. corresponding to a tractive effort of 15,600 pounds at a speed of 37 miles per hour. The maximum speed of these locomotives will be 56 m.p.h. The profile over which these locomotives will operate does not justify the use of regenerative electric braking so that this feature will not be included in the design. These engines will be required to haul trains of 260 to 350 tons on the local runs, including the 300-ton trains of the Los Andes branch.

In the interest of improving the service, faster schedules are desirable. These cannot be obtained with the present steam equipment and in fact with heavy traffic the present time tables are maintained by double-heading on the grades. With electric operation it is proposed to reduce the running time of the fastest passenger trains between Valparaiso and Santiago from three hours and forty minutes to three hours and fifteen minutes, or a twenty-five minute reduction in running time. The way passenger, as well as the local trains will also operate at

higher speeds, with a consequent reduction in running time.

The switching will be performed by 65-ton double truck locomotives. These locomotives will have a rating of 480 hp. or a tractive effort of 15,600 pounds, at a speed of 11.6 m.p.h.

Locomotive Maintenance and Renewals

The maintenance of the steam locomotive equipment is of a high order on the State Railways. Many of the executives of the State Railways have had foreign experience in railroad shops of the largest systems in the United States and England—a number at the Altoona shops of the Pennsylvania.

Repairing of electric locomotives does not present a difficult problem to the railroad as the present shop equipment is, with the exception of a few items, adequate to handle this work. High grade skilled labor is available so that with a certain amount of training covering the care and maintenance of electrical equipment, this work can be handled readily.

Chile has purchased most of her modern locomotives in the United States. However, a number have been and are now being reconditioned in her shops, while in the past some have been designed and built there entirely. It is apparent that the wisest course is that of investing in locomotives which will give the longest life in order to avoid frequent foreign purchases. The electric locomotive fills this requirement and has the added advantage of being ready for service a greater percentage of the time than the steam engine.

In some respects the purchase of electric motive power can be regarded as being part of a program of normal renewal of motive power equipment in view of the necessity of purchasing more steam locomotives to replace obsolete types and provide for increasing traffic.

The maintenance and operation of water stations involves a considerable expense. Furthermore, the loss of time at these stations by the trains represents an additional loss with steam operation that will be eliminated by the new system of operation. Many of these water stations require the maintenance of pumping stations, which represents an added expense.

All steam locomotives are coaled by hand rather than by automatic coaling stations, so that this expense is considerable. The elimination of these stations will make available additional yard trackage.

With continued steam operation it would have been necessary to have invested in a number of new engine houses. This expense is now eliminated, due to the fact that much less space is required by the use of a fewer number of locomotives to handle the service.

Energy generated by hydro-electric plants will be purchased by the railroad for the operation of its trains. One of these generating stations is now in course of construction by the Chilean Electric Tramway and Light Company, Ltd., and known as the Maitines station. From this station, the power will be carried to the receiving station at Santiago and on through to Valparaiso by 110,000 volt transmission lines. The end substations will be served by 1,200 volt transmission lines, while the three intermediate stations will receive their power from 44,000 volt transmission lines fed through stepdown stations from the 110,000 volt lines.

Each of the five railway substations will contain two 2,000 kw. motor generator sets. The sets will supply the overhead lines with direct current at 3,000 volts.

The climatic conditions are remarkably favorable to the successful operation of electrical equipment with the possible exception of that part of the line located along the seashore which requires consideration on account of the salt air from the ocean. The rainfall is limited in this district and snow is unusual. In the summer season the air temperature is high in the daytime, due to intense sun, while the nights are always cool due to the cool air from the Andes Mountains.

Storms are almost unknown except by the sea shore. The wind velocity is very low, especially in the Los Andes branch district. Even lightning is infrequent, and is not severe in the district of the first zone.

It may be said that the electrification of the first zone of the Chilean State Railways solves most, if not all, of the serious operating problems of this section of the system. The advantages to be gained by electric operation are:

(1) An increase in the capacity of the present trackage to provide for future increase in traffic.
  a. Faster schedules.
  b. Heavier trains.
(2) A reduction in operating expenses by reducing
  a. Fuel costs.
  b. Locomotive maintenance costs.
  c. Crew costs.
  d. Elimination of coaling and watering stations.
  e. Reducing track maintenance costs.
(3) Provision for motive power and rolling stock additions and renewals.
(4) Better traveling conditions.

The full realization of all the operating economies will be attained when the entire system is electrified so that all advantages can be taken of the characteristics of electric motive power.

The European railway schedules are not yet quite up to the pre-war figures. Before the war the Northern Railway of France had an express running from Paris to St. Quentin, 95.7 miles, in 95 minutes. The North Eastern of England was scheduled to cover the 44.3 miles from Darlington to York in 43 minutes, while the Great Central Railway express from Marylebone, between Rugby and Leicester, ran at a rate of 61.3 miles per hour.

Copyright by Keystone View Co.

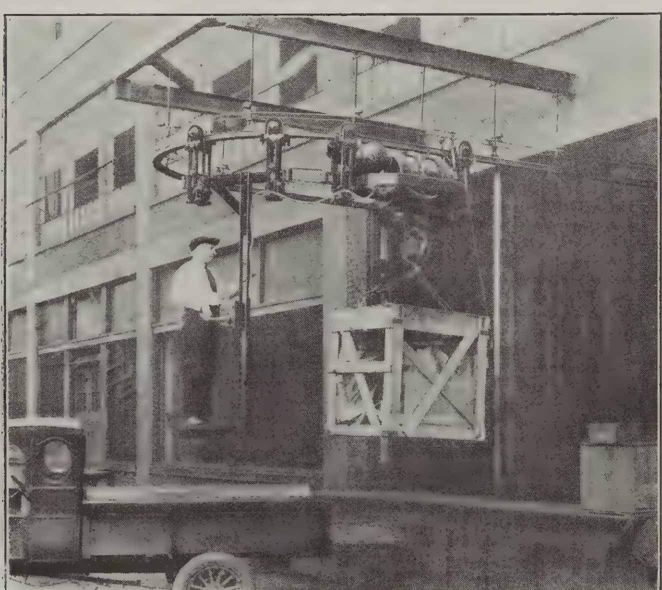
Railway Station at Lucerne, Switzerland, as Seen from the Air

A New Overhead Handling System

It is generally conceded that mechanical methods of handling materials are more economical than manual. Consequently, in the efforts towards reducing costs of operation, the railways are utilizing mechanical devices in increasing numbers. In numerous freight terminals, repair shops, machine shops, etc., where floor space is at a premium, the space overhead is little used. Under such conditions the overhead methods of handling cranes, monorails, tramrails, etc., offer a solution of the problem. The Cleveland Crane and Engineering Company, Wickliffe, Ohio, has developed a tramrail for use in such localities for which important advantages are claimed.

In the freight terminal the tramrail makes a straight-line movement of outbound l.c.l. freight from a shipper's vehicle into any one of a large number of cars awaiting loading; for inbound freight, a similar movement from any car to some spot in the inbound house and thence, on call, to the consignee's vehicle. The system saves floor space and speeds up delivery. Its use on the railways is not restricted to the handling of freight as it may also be applied in railway shops in the handling of parts to and from the repair job and in the repair shop, machine shop, etc.

Flexibility of the installation of the rail, which can be attached to the purlins of a building or most any support available through the adaptability of the suspension fittings to varying conditions, is the feature of this tramrail. The entire system is standardized so that a mechanic possessing a common knowledge of machinery can layout, order and instal the rail, rail fittings, switches, turntables, carriers, etc. By use of cold bends in the rail any curve down to a 4-ft. radius can be negotiated without a sacrifice of safety.



The Tramrail as Applied to Freight Handling

The sliding switch designed especially for this tramrail is a departure from the usual type of switch employed in overhead systems. Like the other units of the system the switch is standard and possesses distinct advantages. The same switch is installed whether for hand power or electric operation. This permits the hand power system to be electrified at any time. Both the stationary and movable rail in this switch are held in firm contact, eliminating the open space at the point where the rails join. Special attention has been given to safety at this point, with the result that the instant a switch is opened a safety stop drops on the rail, preventing the carrier from passing that point. When the switch is in position, it is automatically locked, thus preventing the carrier and its load from sliding the switch out of alinement. When desired, an additional safety feature, the installation of a trolley wire insulator, makes it impossible for an electrically driven carrier to run at full speed against a safety stop or open switch.

It is often found necessary to instal the rail at different levels. This means that the carriers must negotiate a grade. The electrically driven carrier has ample power to operate with its full load up to a grade of 12.5 per cent. This makes the employment of a brake essential and a foot brake is provided on carriers which travel a grade. Where the difference in levels means excessive grades an ordinary freight elevator is installed with the tramrail.

By use of a central control system, one man can operate several carriers. Where an unobstructed view of the system is impossible, the operator is informed as to the location of the carriers he controls by signal lights on a board before him. With this arrangement the dispatcher can switch the carrier to any track or location desired.

Approximately 1,200 types of carriers are available through the combinations of the standard equipment. It should be noted that all working parts are fully enclosed as a protection from fumes, moisture and dirt. The ball bearings and other bearings, of bronze graphite inserted bushings with ample provision for self-lubrication are readily accessible if it becomes necessary to remove them.

One does not often hear of railroad tracks being used for a highway. However, the Southern Pacific reports that at Barnard, Cal., two machines occupied by eight people turned off the county road at a crossing because of snow and started down the tracks, which had been cleaned by a snow plow. One of the machines stuck in a frog and the other slipped from the ties to one side when the Shasta Limited came along, the engineer stopping the train only two car lengths from the first machine.

Photo by Underwood & Underwood

Railway Station at Cape Town, South Africa

Principles of Car Lighting by Electricity

A Course of Practical Lessons Explaining the Main Details of This Important Application

By Charles W. T. Stuart

XVII.—The Gould Simplex System

THE Gould "Simplex" system of car lighting consists of a generator, driven by a belt from the car axle, a generator regulator panel, a lamp regulator panel mounted in a cabinet inside or under the car body, and a storage battery which is suspended in a box under the car body.

The fundamental principle of the Gould axle lighting system is the combination of a constant current and a constant voltage control, acting successively, which results in a straight line charge through the major part or the whole of the charging cycle followed by a period in which constant voltage is maintained while the charging current tapers off to a low value. The taper is gradual or abrupt according as the voltage element is arranged to maintain the maximum battery voltage or a lower value. For example, starting with a fully discharged battery, assume that the generator is delivering a charging current to the battery that is held constant at 45 amperes. The voltage of the generator increases a sufficient amount to compensate for the increase in battery e. m. f., thereby sending a constant current of 45 amperes through the battery. This increase of battery and generator voltage continues until the generator voltage has risen to approximately 39 volts for lead batteries and 43 volts for an Edison battery; then the voltage regulating coil goes into operation and holds the generator voltage constant at that amount. The operation is changed at this point from current to voltage regulation, and since the counter-electromotive force of the battery keeps rising and as the generator voltage is limited to 39 volts for lead batteries and 43 volts for the Edison battery, the current will gradually decrease or taper as the battery continues to charge. (Thus, we start with a constant current charge and finish with a taper charge.) But if the voltage element is arranged to reduce the generator voltage somewhat when it takes control and maintain the reduced voltage, the taper becomes practically an abrupt termination of the charge.

Generator

The generator, a cross-section of which is shown in Fig. 1, is a four-pole, shunt-wound machine designed to give sparkless commutation throughout the range of loads and speeds met with in car lighting. The Gould generators are suitable for both body and truck suspensions. They are also made in 1.4, 2, 3.4, and 4 kw. sizes with speed ranges as shown in the accompanying table. As far as possible, similar parts are made to be interchangeable among the different size machines. This flexibility is a decided advantage. The generator consists of the following main parts: magnet frame, pole pieces, field coils, armature, bearings, pole changer, brush holders, and brushes.

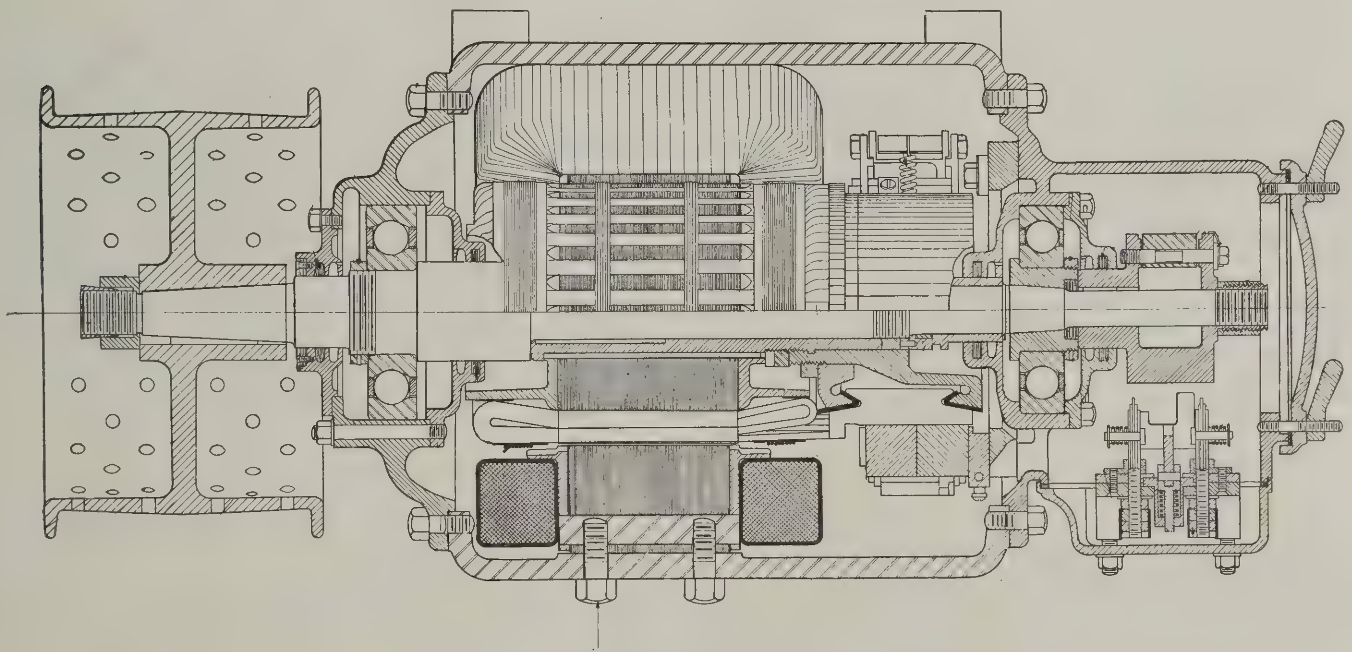


Fig. 1—Cross-Section of the Gould Axle Generator

The magnet frame is a one-piece steel casting; the supporting lugs being cast solid with the frame. The housing heads which carry the bearings are made of cast iron

and bolted to the magnet frame at each end. Hand holes, with water and dust-proof covers are provided at the commutator end for inspection purposes. The pole pieces are of the laminated type, and bolted to the magnet frame. The armature is form wound with d. c. c. conductors. Each coil is thoroughly protected by tape, treated with insulating varnish and baked before placing in the slots, which are further insulated with heavy liners. The coils are held in the core slots by band wires.

The commutator bars are of hard drawn copper with liberal wearing depth and ample area to carry the maximum output of the generator.

The risers, to which the armature coils are connected, are integral with the bar. The mica insulation is of the best grade mica, having the same rate of wear as the commutator bars.

The armature shaft is made from high grade steel accurately ground to size. The pulley, in addition to having a tapered seat, is keyed to the shaft and locked with a Columbia lock nut. The bearings for the armature shaft are annular ball bearings, of a type especially developed for this service.

The pulley end bearing is pressed directly on the shaft and held by bearing nut. The commutator end bearing is similarly pressed and secured on a solid sleeve having a tapered bore to facilitate removal of the armature without disturbing the bearing. A space is provided around the bearings for grease for lubrication. Grease grooves and felt washers prevent the entrance of dirt into the bearings and the leakage of grease into portions of the dynamo where it should not go.

The brushes are made of carbon and provided with flexible copper pig tails to give positive contact with the brush box. The brushes are arranged in four metal holders, two positive and two negative, connected in parallel. The brush holders are permanently fixed in one position, being mounted on a Bakelite ring, which in turn is bolted to the commutator end housing.

The leads to the generator are brought to a terminal block in the top casing of the commutator end housing and the pole changer is mounted on the under side of this terminal block.

The function of the pole changer, which is of the mechanically operated switch type, is to maintain the proper polarity of the external circuit of the generator, whether the car be running in a forward or backward direction. It consists of a double-pole double-throw knife switch connected between the brush leads and the external leads of the generator and a trip which is arranged in a carrier and mounted on the armature shaft. The trip has two horns which register, respectively, with a front and a rear projection on the switch bridge. During the first revolution of the generator in either direction, one horn or the other engages the corresponding projection on the switch bridge and throws the switch to the position corresponding to the direction of rotation. A spring toggle carries the bridge beyond the reach of the tripping horn and retains it in the new position. Thereafter the trip revolves without touching the bridge, until the direction of rotation is again reversed. When the direction of generator rotation is reversed, it will develop reverse polarity; that is, the positive generator brush will then become negative and the negative, positive. When the direction of car motion is reversed, however, the double-throw switch will automatically be thrown to the opposite side, reversing the main armature leads to the brush holders. In this manner, correct polarity of the external circuit of the generator is maintained. The illustration, Fig. 2, shows the operation of this type of pole changer.

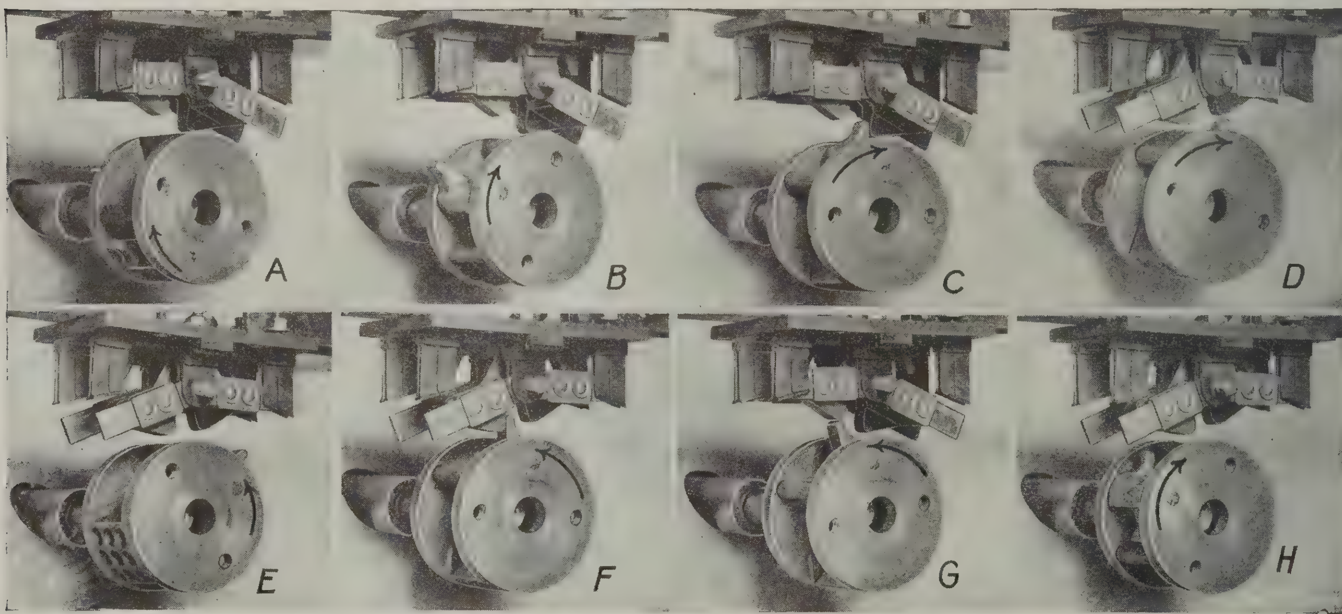


Fig. 2—Series of Pictures Showing Operation of Pole Changer

The table gives the characteristics, weight, etc., of the Gould axle generators.

Type	"AB"	"GB"	"BB"	"CB"	"R"	"R"	"BBX"
Rating	1.4 kw	2 kw	3.4 kw	4 kw	2 kw	3 kw	2 kw
Amperes	35	50	85	100	50	75	50
Volts	40	40	40	40	40	40	40
Cutting in Speed R. P. M.	350	385	390	385	465	720	265
¾ Load Speed R. P. M.	430	480	490	480	585	900	335
Full Load Speed R. P. M.	460	510	520	510	620	950	350
Weight of Generator without Pulley	485	550	655	840	540	540	655
Weight of Armature	75	95	155	180	90	90	155

Generator Regulator

The various types of generator regulator panels are

shown in Figs. 3, 9 and 11. Each consists of a slate panel on which are mounted the automatic switch, field rheostat or carbon pile, two solenoid coils with their respective plungers and connecting lever arms, main fuse and various resistance units.

The automatic switch is of the double break, laminated copper contact type with auxiliary carbon break and is closed against the action of gravity by the lifting of its solenoid core. There are two windings on the solenoid, one a shunt coil across the generator mains, the other a

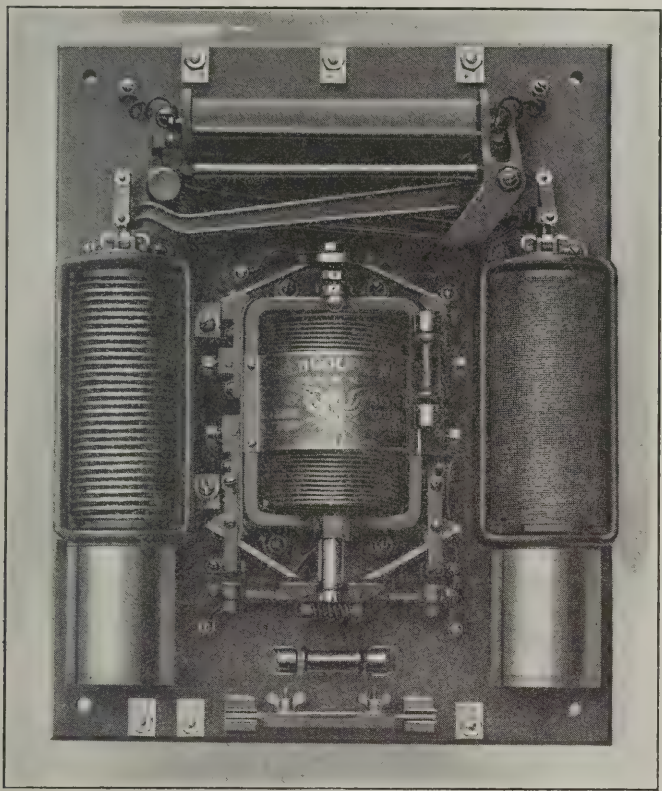


Fig. 3—Generator Regular Panel Type "BB"

heavy series coil connected in series with the generator mains. In series with the shunt or lifting coil is a heat compensating resistance unit mounted on the automatic switch frame. When the generator voltage reaches 33 volts the shunt coil becomes sufficiently energized to raise the plunger and close the switch. The series coil is then energized and assists in holding the contacts or switch, closed. Should the generator speed be decreased and the voltage dropped to that of the battery voltage, the latter tends to discharge through the series coil in an opposite direction, thereby neutralizing the pull of the lifting or shunt coil and gravity, reinforced by the switch springs causes the switch contacts to open. On some of the older types a metal disc is mounted on top of the solenoid plunger which contacts with laminated copper brushes and serves to short-circuit the series coil of the regulator when the automatic switch is open. This prevents the current to the lamp load from exerting an effort to raise the solenoid plunger of the series coil of the regulator and increasing the resistance in the field circuit, which would tend to prevent the building up of the generator.

The field rheostat or carbon pile shown at the top of the regulator panel, Fig. 11, is connected in series with the field circuit. The resistance of this carbon pile is automatically adjusted by the movement of the plungers of the regulating solenoids. The shunt or potential regulating coil, located at the right of the regulator panel, controls a plunger whose lever arm acts directly on the pressure plate at the left end of the field carbon pile. This coil is connected in series with the heat compensating resistance unit located on the right-hand side of the frame of the automatic switch (see Fig. 11), the circuit then being connected across the generator leads. On the surface of this coil is a differential winding, consisting of a few turns of strap copper, connected in series with the battery branch. This winding serves to cause an abrupt taper of current rate at end of battery charge.

The series regulating coil located at the left of the regulator panel, Fig. 11, is made of heavy copper wire through which flows either the battery current, or the total generator current, as desired. The series regulating coil controls a plunger whose lever arm acts directly on the pressure plate at the right end of the field carbon pile.

The resistance unit located on the regulator panel, Fig. 3, below the automatic switch is known as the exciter unit and is connected so as to allow a current of

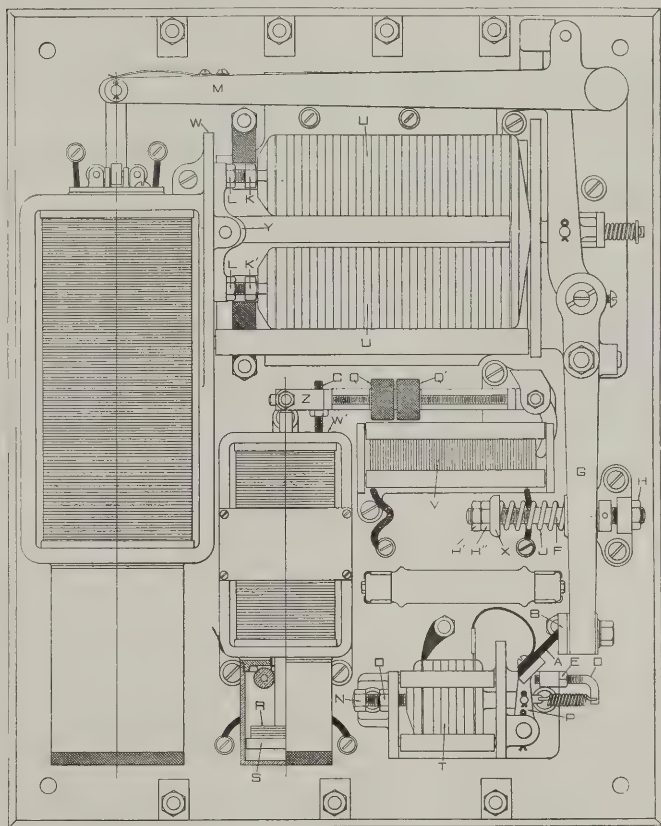


Fig. 4—Outline Drawing Showing Arrangement of Apparatus on the Types "M" and "M2" Lamp Regulators

low amperage to flow through the armature and field circuits when the generator is inoperative.

The main fuse is located on the regulator panel below the exciter unit.

Lamp Regulator

The function of the Gould Simplex lamp regulator, Type M, Fig. 4, is to maintain constant lamp voltage when the battery or generator voltage rises above the normal lamp voltage. It consists of a slate panel upon which are mounted: main solenoid coil, with its plunger and con-

necting lever arms N and dash pot; main carbon files U connected in series or multiple, according to the load; short circuiting carbon pile T with contacts A and B; multiplier solenoid coil with its plunger, lever arm, and dash pot; multiplier carbon pile V; and a multiplier heat compensating resistance unit.

The main solenoid coil is connected in series with the multiplier carbon pile V and the circuit is connected across the lamp mains.

The main carbon pile is connected in multiple with the short circuiting carbon pile T and the circuit is connected in series with the lamps.

The short circuiting carbon pile is controlled by the short circuiting make and break A and B to the right of the pile T.

The multiplier solenoid coil is connected in series with the heat compensating resistance unit and the circuit is connected across the lamp mains.

The lamp current passes through the two large carbon piles U, Fig. 4. An equalizing bar Y is mounted at the left end of the two piles and this, being pivoted at the center, equalizes the pressure of the two piles. The equalizing of the pressure on the two piles will equalize their resistance, and the resistance of these two piles determines the voltage drop of the lamp current in flowing through them. The pressure on these two carbon piles is controlled by the magnetic pull of the main solenoid coil on its plunger, the pull on the plunger being transmitted through the lever arm.

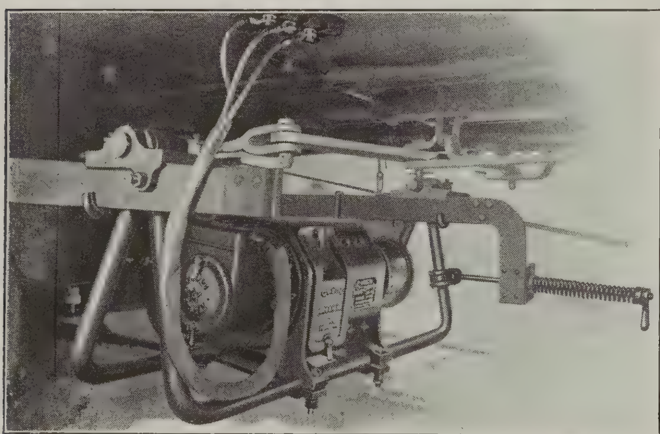


Fig. 5—Two Point Bearing Truck Type Suspension

The function of the multiplier is to make the action of the main solenoid coil very sensitive to slight variations in lamp voltage. As stated above, the multiplier coil is connected across the lamp mains so that it receives all variations in lamp voltage.

A slight rise in lamp voltage will increase the magnetic pull of the multiplier solenoid coil on its plunger. By this action a pressure is transmitted through the connecting lever arms to the small carbon pile V. The increase in pressure on this carbon pile will decrease its resistance, and, since this carbon pile is in series with the main solenoid coil, the decrease in resistance of the carbon pile will cause an increase in the current flowing through the main coil. The increase in current through this solenoid coil with strengthen its magnetic pull on its plunger, and this acting through the lever arm M will release the pressure on the large carbon pile U, thereby increasing its resistance and reducing the voltage on the lamp circuit to compensate for the slight rise in voltage.

A decrease in the lamp voltage will cause the reverse action. The current through the multiplier solenoid coil will decrease slightly, allowing its plunger to fall a trifle and the pressure on the carbon pile V will be slightly decreased, thereby increasing its resistance. The increase of this resistance, which is in series with the main solenoid coil, will cause the current through the main coil to be decreased and with the decrease in magnetism of the coil, will allow its plunger to fall slowly. As it falls, it carries the lever arm with it, increasing the pressure on the carbon pile, U, thereby decreasing its resistance. The decrease in resistance of the large carbon pile U, increases the voltage on the lamp circuit to compensate for the fall in lamp voltage. In this manner the lamp voltage is maintained constant.

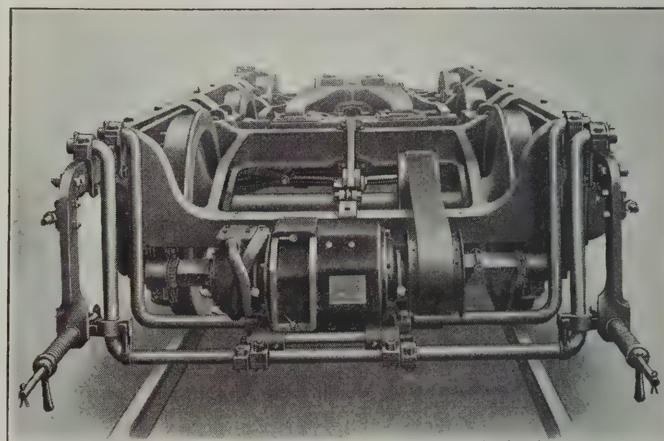


Fig. 6—Link Type Four Point Bearing Truck Suspension

The small short circuiting carbon pile T is connected in multiple with the main carbon pile U. The lever G regulates the pressure on the small pile T. The lever G also carries the contact which makes and breaks with the brush contact A.

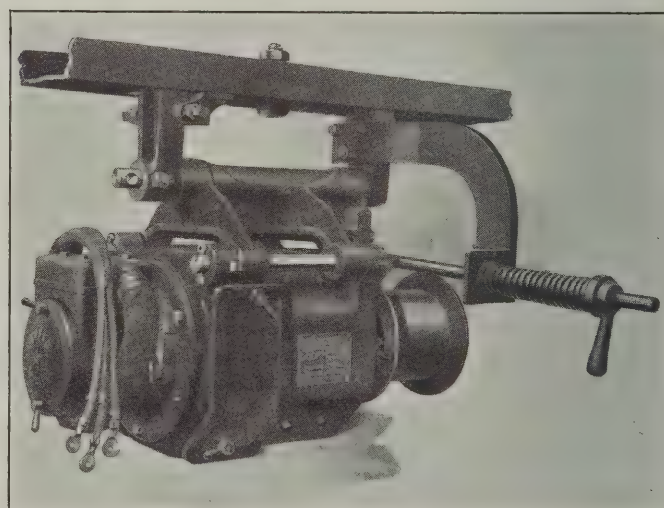


Fig. 7—Adapter Type Body Suspension

When the lamp voltage is normal the lever G is moved by the action of the upward movement of the main solenoid coil plunger and lever M so that the short circuiting carbon pile circuit is open at the contacts A and B.

When the lamp voltage is below normal, the main sole-

noid coil plunger will travel to its extreme downward position, which action, through the levers M and G, close the switch contacts A and B, connecting and compressing the short circuiting pile T in parallel with the main carbon pile. This action practically eliminates all voltage drop across the regulator, when the lamps are burning off the battery, thus avoiding waste of power in resistance.

Suspension

Gould axle generators are suspended either from the truck or the body.

The truck suspensions are of the 2-point link type, as shown in Fig. 5, or 4-point link type, as shown in Fig. 6.

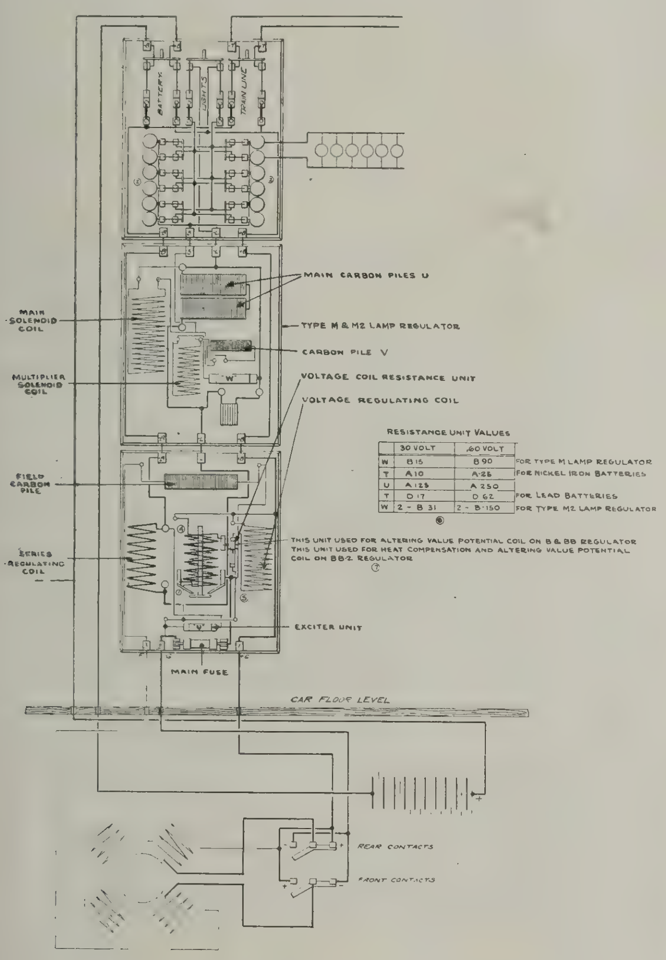


Fig. 8—Wiring Diagram Generator Regulator Panel Type "BB" and Lamp Regulator Panel Type "M"

The same generators may also be suspended from the car body by using the adapter type body suspension, Fig. 7. The Type R generators are provided with integral suspension arms for body mounting only.

Operation

Fig. 8 is a wiring diagram of the Type BB Simplex axle lighting system, and the operation is as follows: When the car is standing still and the generator inoperative the current to the lamps is furnished by the storage battery. When the car is in motion the generator voltage will build up, due to the residual magnetism of the field pole pieces and the magnetism produced by the flow of the exciter current through the field coils. At slow speeds there is generated in the armature a low voltage which forces a small amount of current through three parallel circuits, comprising the automatic switch lifting coil circuit, the field circuit and the voltage regulating coil circuit.

While the voltage regulating coil circuit is alive at this time, it remains inoperative until the battery is fully charged. As the speed of the armature increases and the current in the field circuit increases the field magnetic strength, the generator voltage also increases until it reaches 33 volts, at which time the automatic switch closes and connects the generator to the car wiring.

The instant the automatic switch closes, all circuits become energized, the machine furnishing current for any lamps that may be turned on, but delivering only a small amount of current to the battery. As the speed increases the generator voltage rises and increases the battery charging current until it reaches the value for which the series regulating solenoid is set. Assuming that the battery be in a discharged condition, the generator voltage will now be about 35 to 38. The flow of this current through the series regulating coil magnetizes the plunger of this solenoid and any increase in current above this amount produces a magnetism of sufficient strength to lift the plunger and its lever arm, which movement is transmitted to the field carbon pile, increasing the resistance of this carbon pile and reducing the field magnetism until the current falls to its normal value. In this way the battery charge is held pactically constant at all speeds when the battery is in need of charge.

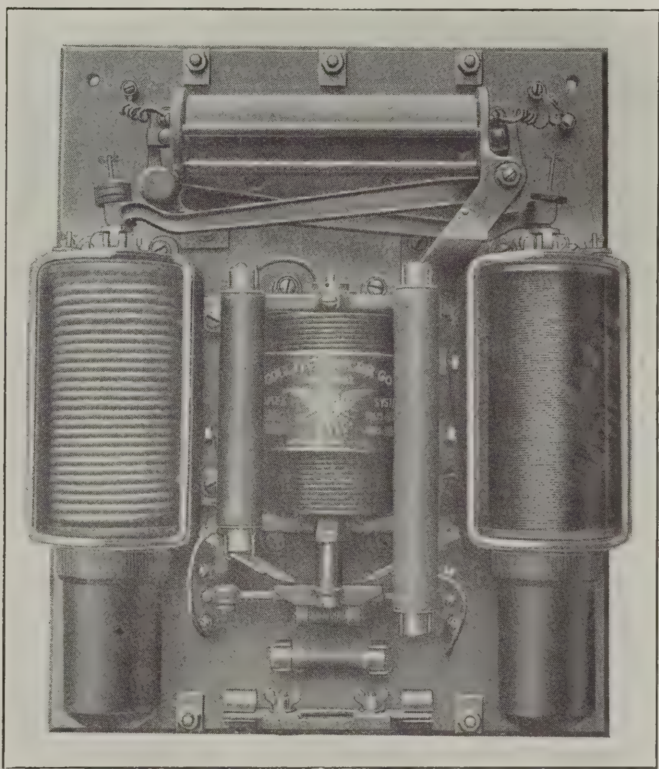
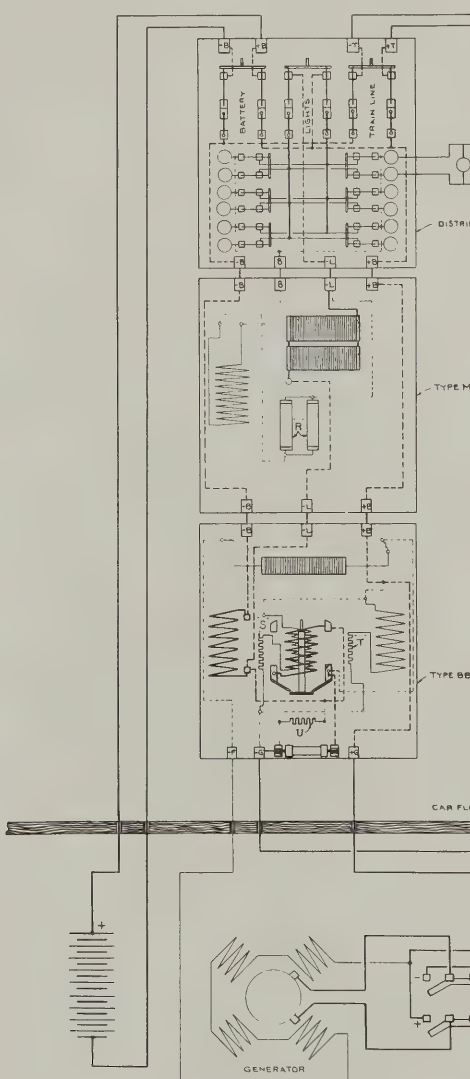


Fig. 9—Generator Regulator Panel Type "BB9"

From the instant the generator starts to build up, the voltage regulating coil is alive but the current through it is not sufficient to produce the magnetism necessary to lift its plunger. However, the generator voltage gradually increases as the batteries become more fully charged, and this rise in voltage effects a corresponding gradual increase in the current through the coil, until the battery

is substantially fully charged, when the generator voltage will be about 39 volts for a lead battery and 43 volts for an Edison battery. The current through the voltage regulating coil will then produce a sufficient magnetism to raise the plunger and decrease the pressure on the field carbon pile thus increasing the resistance of the field circuit, which in turn reduces the magnetism in the pole pieces. Any tendency toward further rise in generator voltage is met by a further lifting of the shunt coil plunger so that the maximum voltage obtainable, when a lead battery is used, is 39 volts. Where the copper strap winding on the surface of the potential solenoid coil is not employed the machine continues to operate after the batteries have been fully charged, the voltage



	30 VOLT	60 VOLT
R	C-20	C 81 (1)
S	P 31	P-92
T	D-17	D 62
U	A-125	A-250

Fig. 10—Wiring Diagram of Generator Regulator Panel Type "BB9" and Lamp Regulator Panel Type "M-3"

remaining constant at 39 and the current gradually tapering as the counter e. m. f. of the battery increases.

The voltage limit of 39 is for a lead battery. When Edison batteries are used a voltage of 43 is required for a full charge. This increase in regulated voltage is obtained by increasing the resistance of the voltage regulating coil circuit. To do this it is only necessary to substitute a heat compensating unit of higher resistance for the one that is in series with the voltage regulating coil. By increasing the resistance of the voltage regulating coil circuit in this manner the current in the circuit will not produce sufficient magnetism to lift the plunger and decrease the carbon pile pressure until the generator voltage has reached 43.

Where the differential strap winding is employed, the potential solenoid, after assuming control, regulates at a voltage practically equivalent to the floating voltage of the charged battery. The series winding is connected differentially to the shunt winding, and accordingly as the current to the battery drops off as previously described, the differential effect of this coil is similarly affected. The potential of the fully charged battery on charge is required to bring the solenoid into action, the shunt coil being bucked by the differential winding with full battery charge flowing; but as the battery charge diminishes, the bucking action is similarly affected, and the controlling voltage diminishes until a point is reached where the voltage is only sufficient to practically float the battery across the line. In case of an opening in the battery circuit while in service, this feature is most attractive,

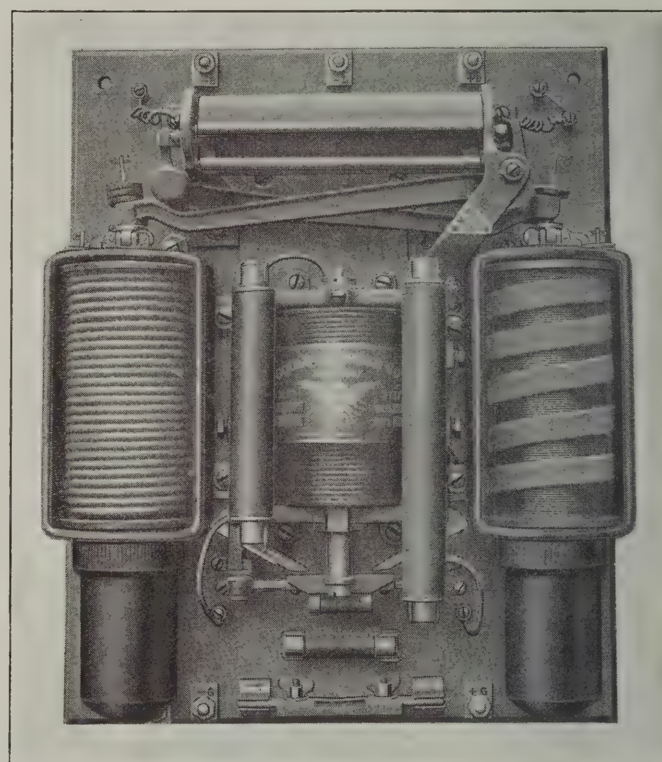


Fig. 11—Generator Regulator Panel Type "BB9B"

as it assures the controlling of the generator at the floating battery voltage, instead of at some higher and excessive voltage.

When the regulator is connected for constant battery charge plus lamp load, lamp current furnished by the generator does not pass through the series regulating coil, therefore the total generator current will be, if the battery is in a discharged condition, the normal battery charging rate, plus the lamp load. When the regulator is connected for constant generator output, all generator current will pass through the windings of the series regulating coil.

Operation of the Lamp Regulator

Referring to the wiring diagram, Fig. 8, it may be noted that the current to the lamps from the battery or

generator passes through the two main carbon piles U. It may also be noted that the multiplier solenoid coil circuit and the main solenoid coil circuit are connected across the lamp circuit on the load side of the main carbon piles U. Therefore the rheostatic effect of the carbon piles governs both the lamps and the operating circuits of the regulator. The lamp regulator is adjusted for a lamp voltage of 30.5 volts. A sudden decrease in lamp load will momentarily subject the lamp circuit to a higher voltage, but the same high voltage is impressed upon the multiplier solenoid coil forcing increased current through this circuit, which action results in sufficient increase in magnetism to lift the plunger of the multiplier solenoid

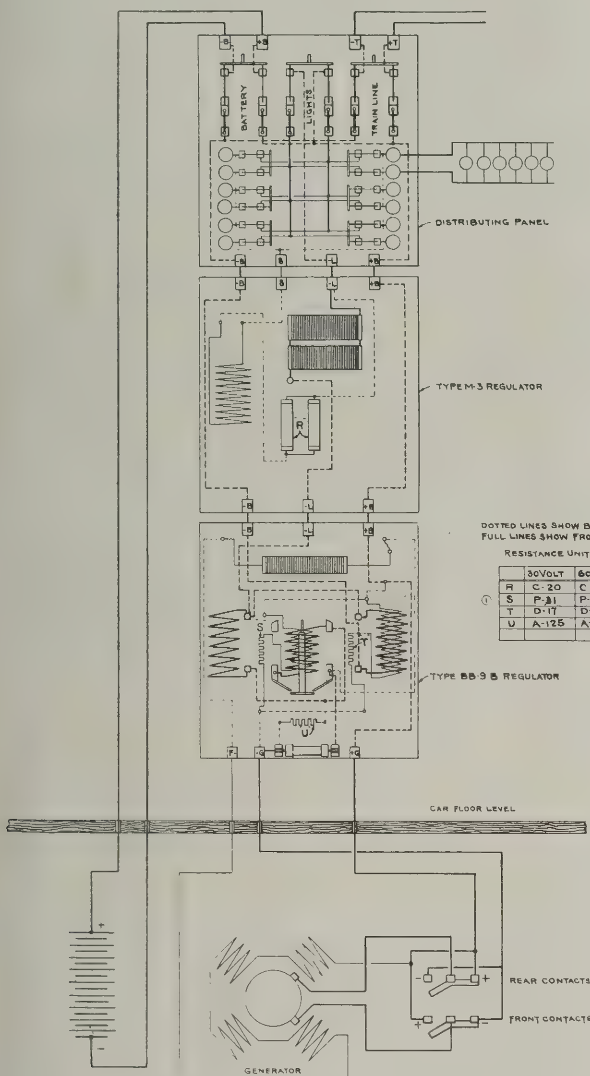


Fig. 12—Wiring Diagram of Generator Regulator Panel Type "BB9B" and Lamp Regulator Panel Type "M-3"

coil and increase the pressure on the carbon pile V. As this pressure is increased the current is increased in the main solenoid coil circuit, which action results in sufficient increase in magnetism to lift the plunger of the main solenoid soil. This decreases the pressure on the main carbon piles U, with the resultant reduction in lamp voltage. Therefore the voltage on the multiplier and the main coils decreases with the lamp voltage, which effects a reduction in the coil current and magnetism until the voltage is reduced to 30.5 volts. When this takes place, the mechanical and electrical forces will balance and no further movement will occur until there is a further change in voltage.

If the lamp voltage drops below normal, the reverse action takes place. The magnetic effect of the main and multiplier coils is reduced and this in turn reduces the voltage drop of the main carbon piles U, increasing the lamp voltage. This increase continues until the regulator reaches its balanced condition when the lamp voltage should be normal or 30.5 volts.

Adjustment of Generator Regulator

The guide rollers on top of the solenoid frame, Fig. 3, constitute the stops for the extreme downward travel of the actuating levers. In placing the carbon discs in the support rack, just enough discs should be placed therein so that when both levers are down (the regulator at the time being inoperative and the discs cool), one lever should be from 1/16 in. to 1/8 in. off its stop with the

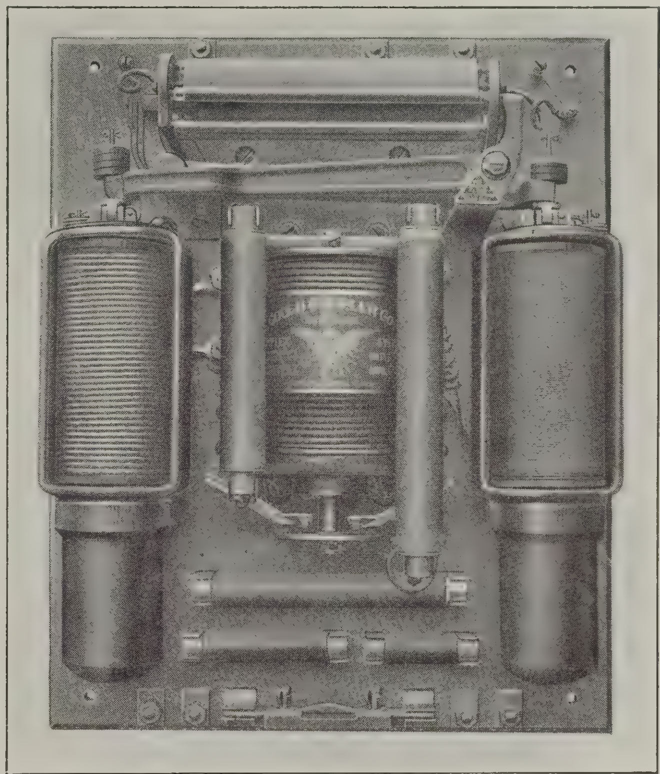


Fig. 13—Combination Generator Regulator and Lamp Regulator Panel Type "A9"

other resting on its stop. Under these conditions the carbon pile is under its greatest compression and the generator can then get its maximum excitation. The current and potential control solenoids are adjusted and balanced against their respective magnetic pulls by weights riveted to the dash pot pistons or applied to pins on the ends of the levers. These adjustments are made at the factory at their proper values corresponding with the rating of the generator and must not be changed, unless a change in controlling value is desired.

Adjusting the Automatic Switch

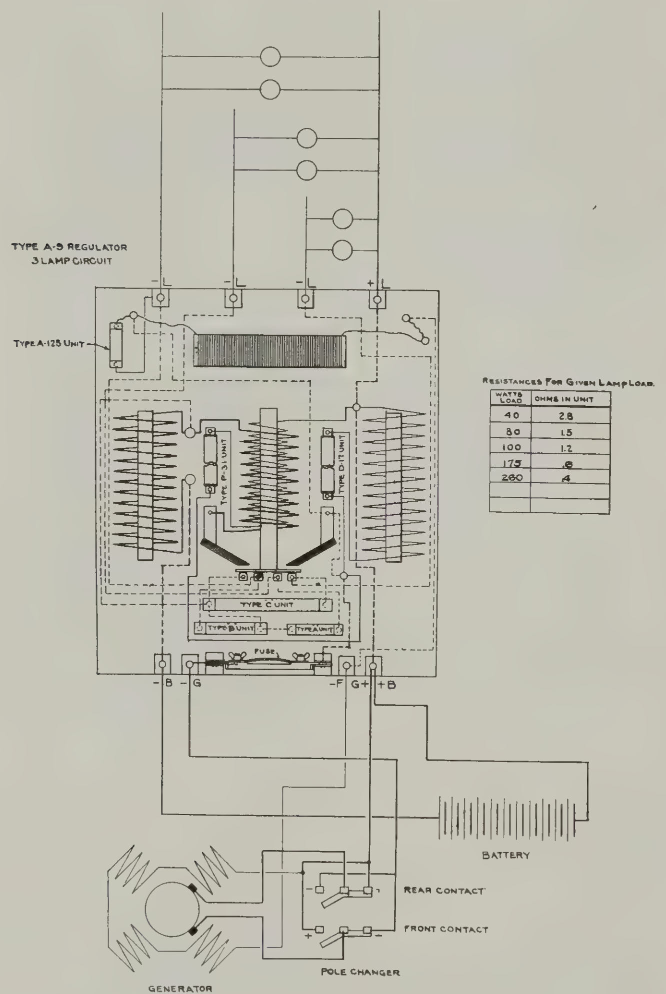
The automatic switch is set and adjusted at the factory to cut in and out at 33 volts. Should it be desired to change this adjustment proceed as follows:

Loosen the set screw at the top, which locks the upper core, and screw the core in to make the switch cut in at

lower voltage, and screw the core out to raise the cutting-in point. The carbon contacts should engage $^1/_{16}$ in. ahead of copper contacts, and the carbons should be kept adjusted to this distance at all times. Where the auxiliary contacts are provided on top of the automatic switch the upper and lower metallic contacts should be so adjusted that the upper contact opens when the lower contact has advanced approximately $^1/_{64}$ in. beyond the lower contact and vice versa. This is to insure a firm connection on the lower contacts before opening the upper contacts and in the opening of the switch to insure the closing of the upper contact before breaking the lower metallic contact.

Adjusting Type "M" Lamp Regulator

In adjusting Type "M" lamp regulator, Fig. 4, block the main lever M in a position at least 1 in. above the stop W, and adjust stud F so that the lever G is in a vertical position, then adjust D stud so that the tip of brush



WATTS LOAD	OHMS IN UNIT
40	2.8
80	1.5
100	1.2
175	.6
260	.4

Fig. 14—Wiring Diagram Type "A9" Combination Generator Regulator and Lamp Regulator Arranged for Three Lamp Circuits

A will be separated by about $^1/_{32}$ in. from contact button B. Then readjust the stud F so that the tip of brush A is exactly $^1/_{32}$ in. from contact button B. Now lock the studs D and F in these positions by nuts E and H, respectively. Next, by means of the cap screw N adjust the short-circuiting carbon pile T so that, with the carbon plates normally in very loose contact, the movement of the lever P necessary to cause an increase of $^1/_{32}$ in. in the gap between brush A and button B will bring the carbon plates in pile T under full compression. Lock the cap screw N in this position by tightening the nut O. The spring J, which controls the degree of compression reached in the main carbon piles U and U', should be compressed until the distance between the lever G and the retaining washer X measures approximately 1⅜ in. By locking together nuts H' and H'' the spring can be held in this position.

Now allow lever M to return to its lowest position

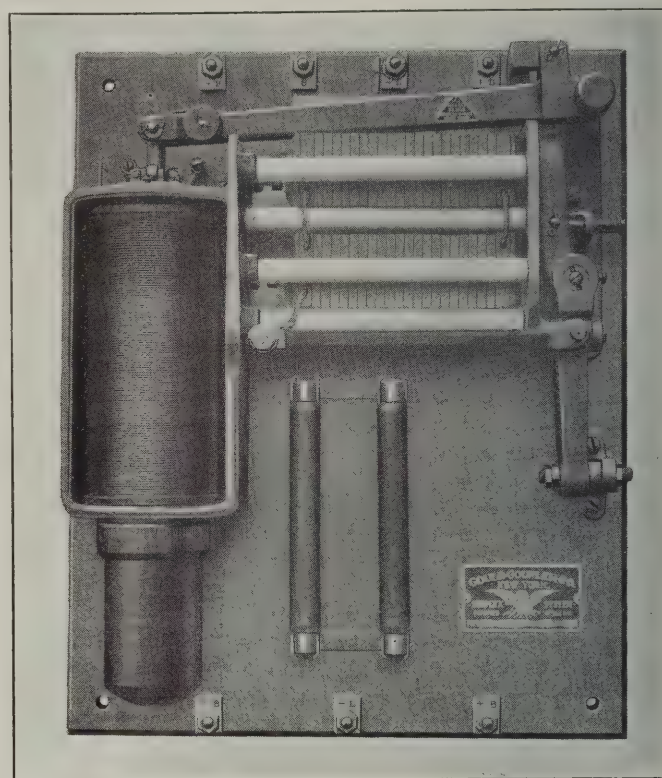


Fig. 15—Lamp Regulator Panel Type "M-3"

against the stop W and by means of the cap screws K and K' compresses the main carbon piles U and U' until full compression is on the piles, which can be best determined by observing the lever M, which will be caused to rise as soon as piles U, U' and T are fully compressed. The equalizing lever Y should be kept as nearly vertical as possible by dividing the adjustment between the two screws K and K', the nuts L and L' are for locking these screws in place.

On the multiplier the stud C should be so adjusted as to let the lever Z come down to within approximately ⅝ in. from the magnet frame W'. Enough carbon discs should be placed on the pile V to permit full compression of the pile by approximately ⅜ in. upward movement of the lever Z, and at the same time allow the pile to be entirely released when the lever is in its lowest position. The lamp voltage is raised or lowered by moving the balancing weights Q and Q' to the left or to the right respectively. This adjustment covers a range of two volts. If a further alteration of the lamp voltage is required, it may be accomplished by adding weights R to, or removing weights from the piston S. The lead weights sent out with the regulator will make an increase of approximately one volt for each weight added to the piston.

In setting the regulator the gage, furnished by the

Gould Coupler Co., will be found very convenient as it obviates the measuring of the gaps.

All "Simplex" equipments in their essential features have been substantially described here, but not all of the refinements mentioned were included in the earlier types. The following summary treats of the peculiar characteristics of the various types:

Generator Regulator BB

The Type BB generator regulator, Fig. 3, was as previously described, with the exception that none of the potential coils were provided with heat compensating resistance units, nor was the differential strap winding employed on the potential coil. However, a resistance unit was employed in series with the potential solenoid coil when it was desired to have the regulator adaptable to either lead or nickel iron batteries.

Generator Regulator Type BB-9

The Type BB-9 generator regulator, Fig. 9, included practically all the features of the "BB" and the following improvements:

Means have been provided for compensating for temperature variation in the coil of the potential solenoid, which causes the coil to operate within one volt of its setting under all temperature conditions. This is accomplished by a specially wound potential coil together with a unit of sufficient capacity to accomplish the desired results, this unit being mounted on the right-hand side of the automatic switch.

Similar means have been provided for compensating for temperature variation of the lifting or shunt coil of the automatic switch solenoid causing the switch to operate within one-half volt of setting under all temperature conditions. A resistance unit, mounted on the left-hand side of the automatic switch, and which, in connection with a specially wound shunt coil, accomplishes this result.

The metal disc with auxiliary laminated copper brushes on the top of the automatic switch has been omitted, since through the use of modern types of lamps, the lamp loads have been reduced to a degree not warranting their employment. The solenoid levers are not directly connected to the guide stems of the plungers.

The regulator is fitted with moulded composition dash pots, employed a dashing fluid known as "Dasho" which fluid remains practically constant in its viscosity throughout the entire range of temperature met in service. Fig. 10 is a wiring diagram of Type BB-9 generator regulator and M-3 lamp regulator.

The regulator is connected for regulated battery charge plus lamp load.

Generator Regulator Type BB-9B

Type BB-9B generator regulator, Fig. 11, includes all the features of the BB-9 and the following improvements:

On the surface of the coil of the potential solenoid there has been added a heavy series winding, which is included in the battery circuit and is connected in differential relation to the potential coil. This series winding is so designated that, in combination with the potential coil and a fully charged battery, it will bring the generator potential to a value that will cause the fully charged battery to float. After the regulator has brought the battery to a floating condition, it will continue to regulate at this point indefinitely, or until such time as current drawn from the battery reduces its voltage to a sufficient extent to cause the regulator to again operate on the current side.

This regulation is positive, and being based on the back e. m. f. of the battery, which is the most definite indication of its state of charge, it automatically adapts itself to the actual conditions of the battery, irrespective of all considerations concerning the temperature, leakage and efficiency.

Fig. 12 is a wiring diagram of the Type BB-9B generator regulator and M-3 lamp regulator, connected for constant generator current regulation.

Generator Regulator and Lamp Regulator Type A-9

Type A-9 generator regulator and lamp regulator, Fig. 13, includes all the features of the BB-9 with the exception that resistance units of proper value mounted on this panel are connected in the lamp circuit when the automatic switch is closed. This protects the lamps from the excessive voltage which is applied to the battery while charging and which is short-circuited through contacts and the bottom of the metal disc plate of the automatic switch when same is open, thereby removing the resistance when the lamp current is supplied by the battery. This type of regulator relieves the necessity of an independent lamp regulator and is recommended for baggage cars and other cars with light lamp loads, where very close lamp voltage is not required. Fig. 14 is a wiring diagram of the Type A-9 combination generator regulator and lamp regulator, connected for battery charge regulation plus lamp load.

Generator Regulator Lamp Regulator Type AB9B

This regulator is similar to the A-9 from which it differs by the addition of a differential winding on the potential regulating coil that is described in the case of the BB-9-B regulator, and in the use of a small magnet switch in place of the auxiliary contacts for cutting out the lamp circuit resistance units when the automatic switch is open. The coil of this magnet switch has about the same resistance as the exciter unit used on other regulators, and occupies the same place in the circuit.

Lamp Regulator Type M-2

The Type M-2 lamp regulator, Fig. 4, includes all the features of the Type M lamp regulator and the following improvements:

Means have been provided for compensating for temperature variations in the multiplier lamp regulator coil.

"Dasho" is used in the dash pots of this type of lamp regulator.

Lamp Regulator Type M-3

The Type M-3 lamp regulator, Fig. 15, includes all the features of the M-2 with the exception that the multiplier and short-circuiting carbon pile are omitted and the coil of the main potential solenoid is compensated for temperature variations. This results in a very quick acting regulator and is desirable where this feature is preferred to the exceedingly close regulation, which is obtained through the use of the multiplier.

Wiring diagram of the M-3 lamp regulator is shown in Fig. 10.

Sprague Train Control to Be Tested on New York Central

A CONTRACT has this week been signed between the New York Central Railroad Company and the Sprague Safety Control and Signal Corporation for an intensive test of the latter's system of auxiliary train control on a section of main-line southbound express track No. 2 between Ossining and Tarrytown on the electric division.

This contract is the result of negotiations initiated last February by the Joint Committee on Automatic Train Control of the Bureau of Safety of the Interstate Commerce Commission and the American Railway Association, at which time President A. H. Smith, in response to a suggestion by the Joint Committee consented to a test of the system under suitable conditions provided details could be arranged to the mutual satisfaction of the parties concerned.

This proposal came at a time when the late Public Service Commission (Second District) of New York, had under consideration a proposal to inaugurate tests of a somewhat different character, and was the result of a decision by the joint committee, acting in view of the new conditions created by the mandatory power given to the Interstate Commerce Commission in the Transportation Act, 1920, to test a limited number of devices or systems.

Following the affirmative response of President Smith, the engineering representatives of the Interstate Commerce Commission, the American Railway Association, the New York Central and the Sprague Corporation held a number of meetings to determine the location, extent and character of the tests; and from the locations considered that on the main track between Signal 3002 at Ossining ("PF") and Signal 2652 at Tarrytown ("OW"), 3½ miles, was selected for the installation of track apparatus.

The test determined upon is exceptional, in that instead of a number of equipments being mixed in with the regular traffic and normally subjected to only occasional operation, the experimenters will have a section of track all to themselves. A large number of tests covering every variety of operating conditions will be carried out, practically continuously, for several months, on a reserved section of main track where the highest speed is permissible, and where the equipment can be subjected to a combination of adverse conditions.

While the details of the equipment have not been made public, it is understood that the system, which is of the intermittent magnetic impulse type, embraces in its track elements a series of brake application and differential brake determining magnets fixed in each block well below the heads of the running rails. From these magnets, under the control of the signals and hence of the traffic conditions, momentary magnetic impulses are transmitted to sensitive receivers on the locomotive to initiate primary and secondary breakings. The braking characteristics obtainable can be either service or emergency, and of varying degrees; under speed control, and with or without enforced stops.

The location selected and the methods prescribed for the tests will afford a critical test of the possibilities of automatic train control. Being in the electric division the running rails are used for power as well as for signal currents, and the track elements will be subject to whatever possible interference there may be, not alone from the direct current flowing in the running and third rails, but from any alternating currents used in the signal installation.

Over these tracks will operate not only the steam locomotive under test but likewise heavy electric locomotives and multiple unit electric trains, thus subjecting the track magnets to a variety of extraneous influences. Upon the present normal-clear alternating-current automatic block signal system will be superimposed a direct current "normal danger" track magnet system, the current for which will be derived from the alternating current transmission circuits.

The track on which the tests are to be conducted will normally be kept entirely free from all other traffic for eight hours a day, from 9 a. m. to 5 p. m., for not less than five days a week, during which time all traffic will be handled on the remaining tracks, this arrangement being, of course, subject to emergency traffic conditions. The setting aside of a section of main line track on a railroad of the first class, in its busiest zone, for several hours a day and for several months, and the tuning up of this track so that speeds as high as 70 miles an hour can be made during the tests, was so radical a departure that the contract was only finally concluded after it had been passed upon by the board of directors of the railroad company; an augury of the serious character of the tests to be undertaken.

Preparations for the test have been under way for some time, and it is expected that operations can be begun early in January.

The United States Postoffice Department has been devoting particular attention to the "perfect package" campaign, along with the express and railroad companies. Employees of this department are putting forth every effort to induce mailers and shippers to give more attention to the manner in which their goods are packed, the kind of containers used, and the writing or marking of adequate and legible addresses.

Broad Gage Locomotives Abandoned When Great Western (Eng.) Adopted Standard Gage

The New Dining Car Train

English Dining Car Train of Novel Design

Electric Cooking a Feature in the Recently Installed Service on the Great Northern Railway

THE Great Northern Railway of Great Britain has recently placed in service a dining car train in which all of the cooking is done by electricity. The train operates between King's Cross, London, and Leeds, leaving the former station at 10:10 a. m., and arriving at the latter at 2:10 p. m. The return trip is made in the evening, the time of departure from Leeds being 5:30 p. m.

View of the Kitchen, Showing Ovens

Aside from the electric cooking, the mechanical construction of the train is quite different from the usual type, as may be seen from the photograph at the top of this page. The train is built on the articulated principle, six coaches being carried on five trucks. This construction considerably improves the riding qualities as the oscillations are reduced to a minimum. The weight also is materially reduced which likewise cuts the cost of hauling. The train being constructed as it is with the ends of two cars upon one set of trucks, makes it possible to reduce the distance between the two adjacent coaches very much less than usual. Moreover, since the connection is permanent, the vestibule can be made waterproof and draftproof. Although the Great Northern Railway has operated for many years trains constructed on this articulated principle, the dining car set is the first of its kind, as well as the longest, to be put into service.

The Electric Kitchen

The outstanding feature of the train which marks a radical departure from the usual method in vogue in dining cars, is the electric kitchen. Although certain electric cooking utensils have been used in railway coaches heretofore, it is believed that this is the first dining car train in which the cooking is done exclusively by electricity. For this reason considerable care had to be exercised in the design of the equipment. H. N. Gresley, chief engineer of the Great Northern, is responsible for the idea and all of the development work was carried out under his personal supervision.

As may be seen from the photograph, the main cooking range is located at the left end of the kitchen, a roasting oven and a steaming oven, located above it. Above the steaming oven is a grill and hot water tank. At the right of these ovens there is a boiling range with four hot plates for boiling, frying and heating sauces, etc. Two 10-gallon boiling pans for cooking vegetables also form a part of the equipment. An electric fish fryer 18 in. long, 11 in. wide and 7 in. deep is also provided.

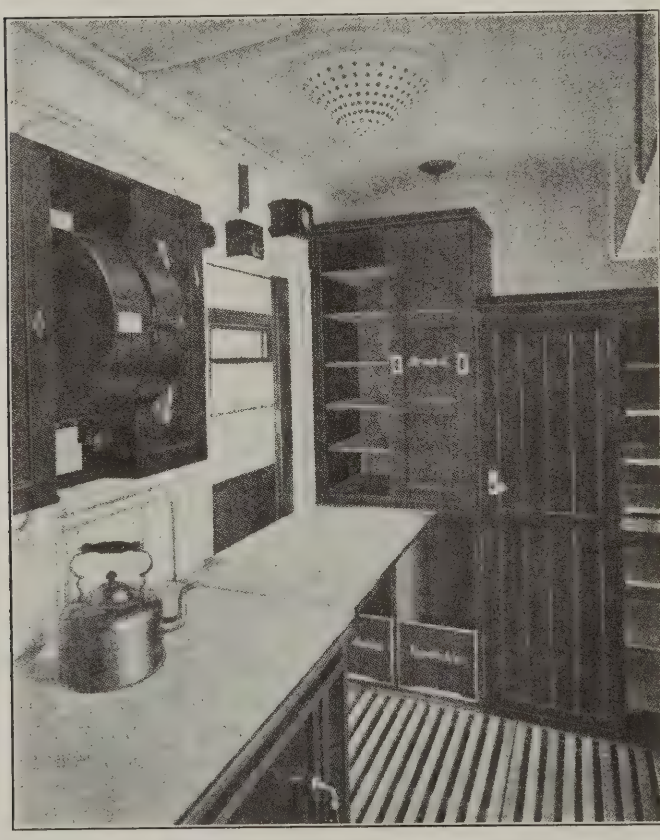
On the right side of the kitchen, between the serving windows, is located a hot cupboard for warming plates, the top of this cupboard forming a convenient table. Warm water is carried in a 40-gallon electrically heated tank situated in the roof of the corridor alongside of the

kitchen, and this tank forms the main supply for the boilers over the ovens. The demand for adequate supplies of hot and boiling water for washing and for other purposes is a very appreciable factor in the current consumption.

Power Supply and Wiring Equipment

The electrical energy utilized for cooking during the time the train is on the road is derived from two 6-kw. belt driven generators and a storage battery composed of 80 cells. For the reason that the run of this particular train is comparatively short, it is necessary to serve lunch shortly after the train is under way, and in order that preliminary operations may be begun before the train leaves the terminal, the wiring arrangement is such that power may be drawn from the station supply, thereby making it possible to use generators and batteries of minimum capacity.

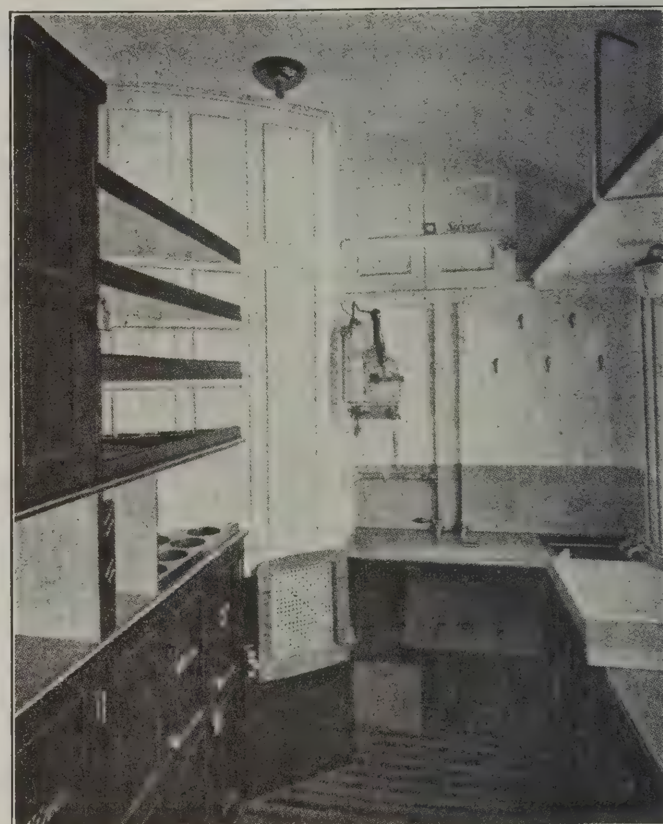
The changeover switch from the station or terminal supply to the battery and generator supply is located within convenient reach of the cook. This switch is operated just before the train leaves the station. Small switchboards, upon which are mounted switches and regulating equipment for each group of apparatus, are also provided. When these switches are closed, small pilot lamps illuminate red glass lenses upon which are inscribed the names of the apparatus in use. This indication serves to prevent the attendant from leaving any equipment in circuit that is not being used.



View of Kitchen, Showing Change-Over Switch and Cupboard

An automatic switch is provided which connects the generator to the battery and cooking appliances as soon as the train has reached a predetermined speed and which disconnects the generators when the e. m. f. of the latter falls below that of the battery. Another switch is so arranged as to divert a part of the current from the battery after it has been fully charged, the current thus diverted being used in heating the water in the main warm water supply tank.

An overload circuit breaker is provided for preventing excessive load being thrown upon the generators or batteries at any time, and should this circuit breaker open it becomes necessary to reduce the current by turning off some of the cooking elements before the breaker can be made to hold in.



The Pantry

The storage battery equipment consists of 80 cells with a capacity of approximately 120 ampere hours, the individual cells being 3 in. by 6⅜ in. by 14¾ in. These cells are arranged 10 in a crate, and the total weight of the battery is 1,880 lb. All of the apparatus is designed to operate on a variable voltage of from 150 to 220 volts. The 150-volt operation is thus derived from the generators and storage batteries on the car while the train is in transit, and the 220-volt supply is derived from alternating current circuits at the terminal stations.

The wiring is carried in enamel conduit which is grounded, as is also the frames and casings of the various cooking equipment. Special precautions are taken to prevent the train being started while the connecting plug is in its receptacle. This is accomplished by locating the receptacle in such a position relative to a valve in the train pipe that it is impossible to release the brakes without first removing the plug. In addition to the alternating current for immediate consumption at terminal stations, provision has also been made to charge the storage battery in case exceptionally heavy demands have been made upon them during the journey. If the ampere-

hour meter on the train shows that the cells are in a discharged condition when the train arrives, the battery is immediately put on charge, the direct current being derived from a mercury arc rectifier.

The plug which connects the kitchen apparatus to the supply mains at terminals is so designed that the plug contact never makes or breaks the circuit. This plug consists of five contact pins. Two long pins carry the main current, while two shorter pins serve to energize a contactor switch located in an iron box between the station tracks. This contact switch closes or breaks the current in the main circuit. When the plug is inserted

Interior of the First-Class Dining Car

in the receptacle the long pin contacts are made first, after which the shorter pin contacts actuate the contactor switch. In the same way, when the plug is withdrawn, the short contact pins cause the contact switch to open before the long pins of the contact plug break their connection. In this way, no arc is ever broken by the contact pins. Moreover, as soon as the plug is withdrawn from its receptacle, the cable is no longer alive. The fifth wire in the plug serves as a ground connection.

Illumination of Coaches

The illumination of the dining coaches is produced by semi-indirect fittings, located in the center of the roof. The fixtures in the first class saloon have alabaster bowls 12 in. in diameter, while those in the third class saloon have obscured glass bowls. Each of the bowls contains four 25-candle power lamps. In addition to the ceiling lighting the first class coaches are equipped with table lamps which brings up the total candle power of these coaches to 750. The third class coach lighting is approximately 600-candle power.

All of the lights throughout the train can be controlled either from the guard van or by the dining car conductor.

Interior Design of Coaches

The keynote of the interior design has been extreme simplicity. The coaches are practically without decoration of any kind. No moldings are used in the first class dining car. The car walls are lined with plain natural colored mahogany panels made as large as possible to reduce the number of joints. The roof and ends of the dining saloon are absolutely plain and are painted a dead white. In the first class coaches the tables are arranged to accommodate six persons in each section. On one side of the aisle is provided a table and four seats, while on the other side is provided a smaller table and two seats. In the third class coaches two tables and four seats are provided on either side of the aisle.

The seats in the first class compartments are of the arm chair variety, upholstered in green tapestry. Polished mahogany tables are used with covers of green morocco leather. In addition, each table has a loose cover of green leather lined with green felt. The floor covering is of Wilton crimson pile carpet, while the lobby at either end of the car is covered with green and white India rubber tiling.

The seats of the third class coaches are also of the arm chair type, the upholstering being in crimson and black pile. In these coaches cork linoleum is used for floor covering.

Discussion on Welding Manganese Steel*

Mr. Wolfe, Asst. Supt., Track & Roadways, Chicago Surface Lines:—In 1907, the city ordinances called for electric welded rail joints or rail joints which would have 100 per cent conductivity. At that time, the Lorain welding process was adopted for making rail joints. This type of joint was used up until ten years ago. However, in the installation of a good many of these joints, the grinding was not done perfectly. The result was, hundreds of joints have been removed since on account of faulty grinding, which leads to cupping of the rails at the joints.

In 1912, we started the Indianapolis welding machine with a high carbon steel wire for building up worn spots on special work. We found that the temper of the metal was destroyed to some extent and that there were apt to be big holes left just inside of the welded area. At present, we keep three equipments working every night building up on special work which is worn out to such extent that it will soon be ready for renewal. We know that it will break soon anyway but we figure on it lasting from one day to six months, but we keep the special work in service until it is worn out all over. That is, the patching up of two bad frogs preserves the layout until the whole thing is ready for replacement.

A short time ago, the Lincoln welder was adopted for the making of rail joints. With the Lincoln process we use a low carbon steel rod for a filler and use a carbon arc with an electrode negative so as not to draw carbon into the weld.

The metallic arc process with a high carbon steel wire is now being used to weld the tops of rails if they are cupped at the joints. This has proven very successful on high carbon rails. After a year's service it is almost impossible to detect the fact that the weld has been made and there have been practically no failures.

Last July the first trial with Wanamaker No. 9 manganese electrodes was made on a layout at Monroe and Clark streets. The Indianapolis welder was used with 550-volt current. The process of quenching, as described in Mr. Pennington's paper, was used as follows: We used

*Discussion which followed the reading of H. R. Pennington's paper on the Welding of Manganese Steel before the American Welding Society of Chicago. This paper was published in full in the December, 1921, issue of the *Railway Electrical Engineer.*

water by the bucketful at first, but it soon became mighty unpleasant for the welder, so now we use as little water as possible, dipping it out of the pail with a tin cup. Fifty or sixty special layouts have been welded in this way so far, using some four hundred pounds of manganese steel wire and they all look like new.

In our work we have found that it is absolutely necessary to have the work rest on a solid foundation if we are to get a good job. No joint should be welded unless it is solid, because there is always a certain amount of weaving. This refers to joint welding.

A point which I think is worth making in regard to this work is, that in order to make sure of getting the longest life for the top of a rail, you must do a good job of grinding. Manganese steel is rather soft at first and will roll down hard—then it will last for years, but the grinding must be done properly to secure the kind of surface that will last the longest.

With reference to the importance of grinding, in welding on track work, it will be well to make a grinder a part of the welding equipment. Every welding crew has a grinder as part of the welding equipment. That grinder stays with the welding machine.

On special work we use an Atlas grinder for heavy grinding and a hand grinder for grinding out the grooves. One difficulty of welding on street railway tracks is that the work must be done under traffic. All of our work on building up frogs and crossings is done at night. The traffic is not so heavy but the work has a large element of danger because there is so much fast automobile traffic. The welder who works on a street railway does not have a very large variety of jobs and the conditions under which he works are very troublesome.

Mr. Jones, Welding Supvr., Illinois Steel Co.:—We have done considerable welding of this nature but I believe that we have found it good practice to use water in considerable quantities. In fact, we squirt it on with a hose and quench two inches of the welded metal at a time. The only failure which we have had was in the welding of a broken rail.

Mr. Wolfe:—The difference in the method of quenching is due to the difference in the method of placing the track. Our work is all on track which is laid in the pavement. The track which Mr. Jones speaks of is out in the open and there is plenty of chance for the water to run away. There is no drainage in the pavement where we work so if very much water is used it all lies on top of the job and the arc cannot be controlled.

Mr. Lacher:—There are a few questions I would like to ask regarding this work. First, how long have frogs welded in this way been in use after welded? Second, how long does it take to weld one of them? Third, can it be done under traffic? Fourth, to what extent have manganese frogs been welded in this manner?

Mr. Jones:—One crossing of this sort at the entrance of our mill was welded eight months ago by Mr. Kincaid. The weld was done under traffic and the crossing is still in service and is subjected to very heavy traffic.

Mr. Wanamaker, Electrical Eng., Rock Island Lines: —The life of these welds has not been completely determined. One manganese weld on carbon steel which was put in last July is still standing up under the hardest kind of service. Another one that I know of which was made several months ago on a poor foundation still looks to be in good shape. It is a little bit too early to attempt to compile definite data but it should be noted carefully that those who have used this process are disposed to continue using it. The cost of putting a special layout in good condition by this process is so low compared to taking the crossing out that the results obtained so far show that the process is worth while.

Mr. Gierach:—Mr. Pennington used rolled rods having physical strength higher than cast rods. He also laid some stress on the matter of coating the rods. May I ask if these features are essential to the work?

Mr. Pennington:—The function of the coating has been thoroughly borne out by experiment in experimental work. The material has "exploded" when coating was not used. The question of whether the rolled rods are better than cast is open to debate.

Mr. Gierach:—A possible objection that I see to the coating is that the duration of the time during which the arc acts is not long enough for a reaction which would result in a complete separation of the foreign matter from the deposit steel.

Mr. Pennington:—The training of the welder has something to do with this. Proper manipulation of the arc floats away the slag. It is true that the tendency for gas inclusion is greater with a coated electrode but proper arc manipulation will float this.

Mr. Wanamaker:—This is quite true. We have never noticed any slag inclusion in the welding.

Photo by Ewing Galloway

Klondike Train at Bennett, Alaska

Ball Bearings for Electrical Machinery

Car Lighting Bearing Trouble Has Practically Disappeared—Other Applications May Prove Equally Important

By H. A. Allen
In Charge of Electrical Development S. K. F. Industries, Inc.

IMPROVEMENTS in the design of ball bearings and improvements in the quality of material used in their manufacture have been made during the past few years which are of considerable importance. Equally important developments have been made in the use of ball bearings. The reasons for applying them to electrical machinery are of particular interest and should be of benefit to the purchaser of machinery in determining whether or not ball bearings should be specified.

Advantages generally credited to ball bearings are that friction is reduced to a minimum, there is practically no wear throughout the life of the bearing, maintenance costs are reduced to a minimum, there are no oil rings to get stuck, little lubricant is required and the bearings have long life. The principal disadvantage is that the first cost is greater than that of a plain or sleeve bearing.

Lubrication

Ball bearings are usually contained within simply constructed housings which also serve as a reservoir for lubricants. Felt washers, labyrinth seals or a combination of the two in the end caps on each side of the housing keep the oil or grease in and foreign matter out.

The purpose of the lubricant is to protect the highly polished balls and races from moisture and other corrosive agents and to reduce the slight friction which occurs between the balls and retainer. Very little oil is needed to maintain lubrication of the bearings and there is little chance for the lubricant to escape.

Due to the methods which can be, and are, used for housing and protecting ball bearings, they are not easily damaged by dirty conditions caused by dust settling around oily bearing heads. The fact that oil is prevented from leaking out of the bearings is quite important also from the standpoint of electrical operation, for oil in the windings or on the commutator is apt to cause trouble. Oil in the windings will cause deterioration of the insulation and oil on the commutator is apt to cause bad commutation. For the last mentioned reason ball bearings are particularly suitable for direct current motors.

In enclosed motors there is a tendency to create a vacuum with the result that oil is sucked out of the bearing into the motor. Motor manufacturers state that ball bearings will prevent this trouble.

Motors which operate at various angles on floors, side walls or ceilings, need special provision for oiling if equipped with plain bearings in order to prevent the lubricant from escaping and doing damage. Ball bearings greatly facilitate the operation of motors under such special conditions.

Maintenance

Under normal conditions it is not necessary to fill ball bearing housings with lubricant more than three times a year.

In general, it can be stated that the cost of maintaining motors equipped with ball bearings is less than that for motors with plain bearings. The internal friction is considerably less in ball bearings so that a supply of oil or grease stored in the housings is sufficient to last a longer time. This means less lubricant and less attention by the maintainer to keep the bearings filled. Oil rings such as are used in plain bearings provide a good means for keeping the bearing oiled, but it is necessary to inspect them at frequent intervals to see that they are turning. They may be gummed by heavy oil and if the weather is very cold they may not start when the motor is started.

In the case of induction motors particularly, the wear in plain bearings calls for periodic inspection and gaging, renewing bearing boxes, rebabbitting, fitting shims and other trouble consequent to getting an exactly adjusted bearing. Such work as this can be performed only by skilled mechanics.

Another possible source of increased maintenance cost to which plain bearings and not ball bearings are subject is the damage caused by the overflow spout being broken off. This sometimes happens without it being noticed until after the oil has drained out and the bearing runs hot. A hot bearing means a shut-down, the necessity of rebabbitting the bearing and the possibility of a damaged motor.

Direct Current Motors

Ball bearings are particularly suitable for use with direct current motors. If there is an appreciable amount of wear in the bearing, the tendency to wear more is automatically increased. Usually the greatest wear is downward, due to the weight of the armature, or to one side or at an angle, due to belt tension. As the bearing wears, the air gap between the armature and the pole pieces on that side is reduced, and the magnetic field automatically increased, which in turn increases the pressure and wear in that direction on the bearing.

An armature which is eccentric to the bore of the field pieces can cause bad commutation in two ways. First, if the motor has interpoles, the interpole field, the function of which is to improve commutation, is distorted and its effectiveness reduced. Second, the wear may affect brush pressure and thereby reduce the quality of commutation.

Commutation may also be materially affected by oil on the commutator, and the possibility of oil getting on the commutator is greatly reduced by the use of ball bearings.

Induction Motors

The application of ball bearings to induction motors due to decreased friction increases the starting torque and affords a means for improved power factor.

The co-efficient of friction in ball bearings is practically the same at the start as at running speed, while it is higher at the start for plain bearings. In the case of

any squirrel-cage induction motor for general service, the starting torque is notably low with respect to the amount of current taken at starting, and an increase of torque, even though slight, is often an important factor. Where a small amount of additional starting torque is desired, it can be obtained by the use of ball bearings.

The power factor of an induction motor may be improved by reducing the air gap between rotor and the stator. As has been stated previously, there is practically no appreciable wear throughout the life of a properly mounted ball bearing and when they are used it is possible to design an induction motor with a very small air gap.

Machine Tool Motors

Aside from some of the general advantages already stated, it is desirable to use ball bearing motors, particularly on machine tools where space is limited and in cases where it is necessary to frequently reverse the direction of rotation.

In cases of individual drive, ball bearings can be applied to a motor in such a manner that they will materially decrease the dimensions in the axial direction. Babbitt bearings are usually designed with the bearing lengths

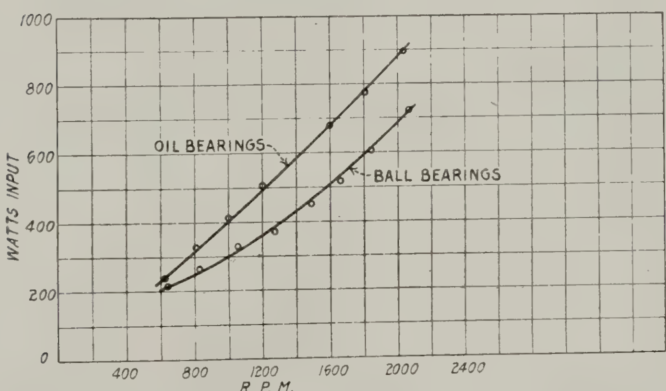


Fig. 1—Result of Test Made Comparing Losses of Ball Bearings and Oil Ring Sleeve Bearings on 230-Volt, 7½-hp. Motor. Driving Motor Losses Are Included.

from 2½ to 3 times the diameter of the shaft which they support. Ball bearing lengths, on the other hand, are usually not over 1⅓ the shaft diameter and project very little beyond the frame of the motor. This often enables motor manufacturers to build a machine of a given rating for a certain location which will be from 10 to 27 per cent shorter than one of corresponding rating equipped with plain bearings. There are many individual cases where the length of an electrical machine is a limiting factor in its design, or the design is affected by the space in which the machine is to be used. It is usually best to have the motor placed low on the frame of a machine tool in order to decrease vibration. This has led to mounting motors inside the cabinet leg of lathes or in the headstock directly under the spindle; on shapers and gear cutting machines it is often enclosed inside of the frames. Reduced axial dimensions may also be of importance where aisles are narrow and floor space limited.

When used on lathes and planers which require a reversing motor, ball bearing motors are advantageous because of their low starting friction. The low starting friction becomes a factor when it is necessary to start, stop and reverse a motor frequently.

Portable Tools

Strength, light weight and compactness are practically always desirable characteristics of portable tools, and the use of ball bearings helps materially in obtaining these desirable characteristics. It is also frequently necessary to use portable tools in unusual and difficult places tilted at various angles, and in these cases it is essential that the machine have bearings from which the lubricant will not escape.

Portable arc welding sets are among those machines

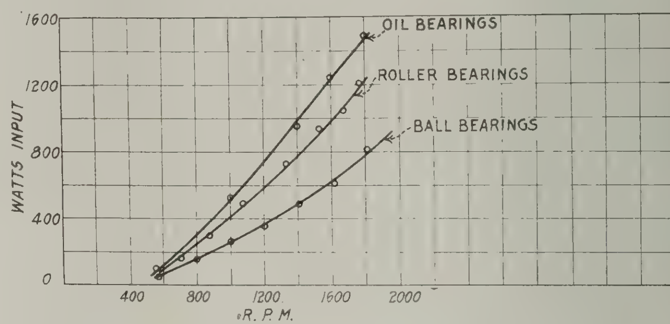


Fig. 2—Curves Show Windage and Friction Losses on 230-Volt, 15-hp. Motor Equipped Consecutively With Oil Ring, Roller and Ball Bearings.

which are often used tilted at an angle. The angle is usually small, but in some cases might be sufficient to allow oil to leak from plain bearings or cause the oil rings to stick. Furthermore, it is often necessary to use them out of doors in the winter time, under which conditions the lubricant may be partly congealed, and under other conditions where the machines may be showered with dust and dirt.

Car Lighting Generators

Practically every car lighting man is familiar with the results which have been obtained by the use of ball bearings on car lighting generators.

Axle generators must be rugged enough to meet the

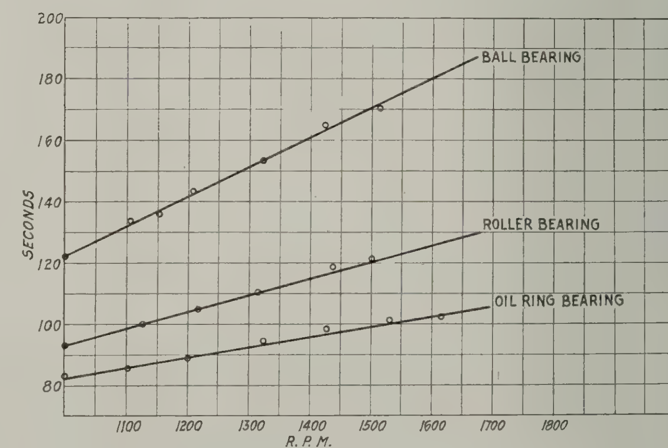


Fig. 3—Curves Show Time Required for Motor to Stop When Current Was Shut Off at Various Speeds. A 230-Volt, 15-hp. Motor Was Used for This Test.

severe conditions of railroad service. Exposure to snow, ice, heat, dirt and water, the jolts and shocks of passing cross-overs and switches and continual jar all tend to play havoc with the generator mechanism. Sleeve type bearings used on car lighting generators require frequent inspection and oiling and are an ever present source of trou-

ble. Ball bearings for car lighting generators have been standardized, are now almost universally used and have demonstrated their ability to stand the severe service conditions. Some ball bearings used in this class of service have been run more than 300,000 car miles, which is equivalent to over one billion revolutions on the bearing.

Locomotive Headlight Generators

Standards have not yet been determined for the bearings of locomotive headlight turbo-generators, although practically all makes are equipped with ball bearings.

The conditions under which bearings operate in this application may well be considered an acid test. The generator is placed on top of the boiler where it is subject to sleet, rain and wind in the winter so that the temperature outside is low while inside it is the same as that of live steam. Hot sun shines down on it in the summer and heat radiates to it from the stack or boiler. All parts of the machine must be able to withstand the effects of expansion and contraction. The running speed of the turbine is usually about 3,600 r.p.m. In spite of the severity of these conditions, ball bearings operate satisfactorily in this service.

Motor Characteristics

Motor characteristics as affected by bearings are shown graphically in the illustrations. The results of an investigation made by the chief engineer of a leading motor manufacturer, which were submitted to a number of electrical engineers employed in iron and steel mill work, are shown in Figs. 1, 2 and 3.

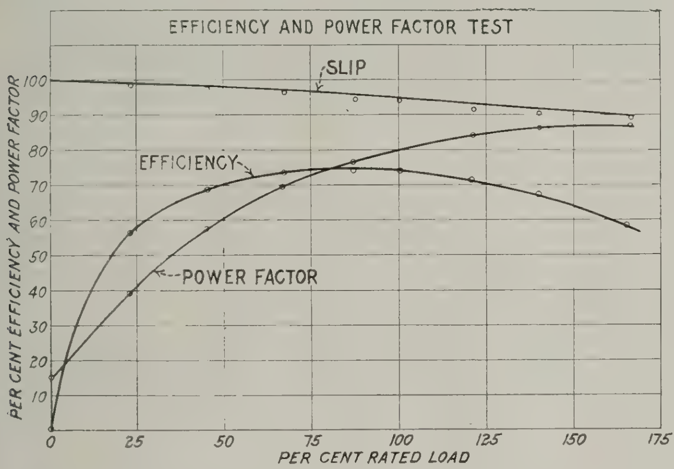


Fig. 4—Possibilities of Motor Design When Ball Bearings Are Used as Shown By These Curves. They Are the Result of Tests Made at the University of Toronto on a 1-hp. Motor.

The results shown by the curve in Fig. 1 were obtained from two motors normally rated at 7½ hp. with a 9¼-in. diameter armature running at 850 r.p.m. The two machines were belt driven at different times by a smaller motor. One of the machines under test was equipped with oil ring bearings and the other with ball bearings.

The curve shown in Fig. 2 represents a somewhat similar test conducted on three motors normally, rated 30 hp. at 850 r.p.m. The motors were identical except for the bearings. In this test the losses of the driving motor were deducted from the watt input and the only inaccuracy is that the losses shown include the belt loss.

The curve shown in Fig. 3 represents test made on the same three motors with the number of seconds that the armature would rotate after shutting off the power plotted against the speed. The results in this test quite closely checked in quantity the values shown in Fig. 2.

Tests made at the University of Toronto with a small ball bearing induction motor gave results which are shown in Fig. 4. The possibilities of motor design when ball bearings are to be used are shown in this illustration. The power factor obtained is 80 per cent at all loads in excess of 90 per cent of normal rating and the efficiency curve attained its peak at about 85 per cent of rated load. The maximum efficiency is applied over the ordinary

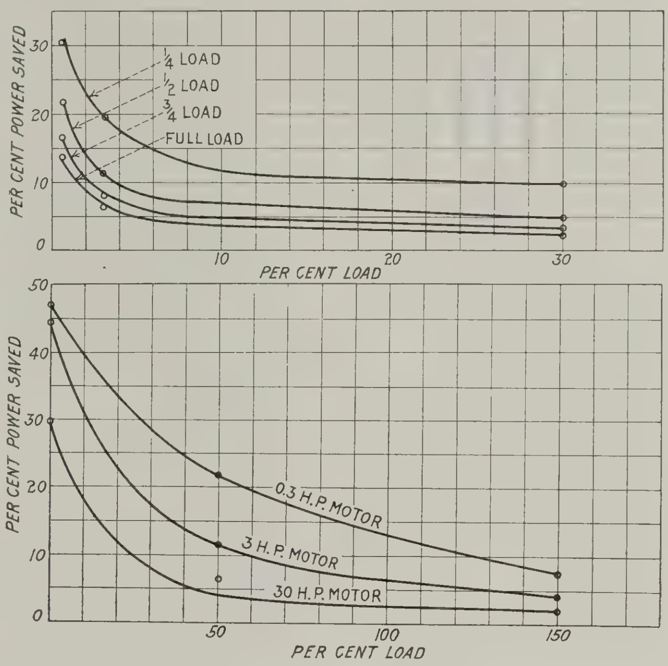


Fig. 5—Curves Showing What Saving May Be Effected By Use of Ball Bearings at Various Loads Up to 30-hp.

average load instead of at rated load or above, and reaches 75 per cent or better at any load between 53 and 113 per cent of rated load. It should also be noted that at quarter load the efficiency is 60 per cent.

The test results shown in Fig. 5 were obtained to show the power saved in .3 hp., 3 hp., and 30 hp. motors. The curves shown in the upper half of the illustration are derived from those in the lower half and indicate what saving may be effected at various loads up to 30 hp.

Photo by Keystone View Co.

Railway Station at Juncal, Chile

Car Lighting Test Apparatus

THE well arranged testing equipment shown in the illustration is a vital factor in expediting the testing of car lighting equipment at a large coach yard in Chicago. In brief the equipment consists of a 5 hp. motor to drive the generator being tested, a switchboard to facilitate connections, a lamp-bank for a load, a rack for holding the controllers, and a storage battery.

The Switchboard

The small panel on the left of the illustration holds an ordinary starting rheostat for controlling the 220-volt d. c. motor used to drive the generator. The main section of the switchboard, a slate panel about 2 ft. 6 in. wide and 2 ft. high, is mounted on 2 in. angle iron. Referring to the picture the description of the equipment may be followed. In the upper left hand corner is a space for mounting certain types of ampere-hour meters to be tested. To the right are three pairs of porcelain-base fuses, the first pair being for the battery feed, the next for the lamp load and the third pair for the generator load. In the right hand corner are two pairs of smaller fuses. The first of these is in the generator field circuit and the other pair is in the circuit with the porcelain test receptacle mounted on the switchboard just below these fuses.

In the center of the panel are two double-pole single-throw switches, one in the battery feed circuit and the other in the lamp circuit. To the right of these switches is an Allen-Bradley carbon-pile rheostat. The single-pole knife-switch mounted at the extreme left of the other switches is connected so as to short circuit this rheostat. The rheostat is connected in the armature circuit of the motor and by increasing the resistance, speeds below normal are attained, thus permitting a test of the pick up and release of the automatic switch under conditions similar to the starting or slowing down of a car in road service. At the bottom of the panel under the switches are mounted ten wing-nut terminals, where all connections to the apparatus being tested is made. Reading from left to right the first pair of these terminals is for the ampere-hour meter; the second pair is for the terminals of the battery, the third for the lamp load terminals, the fourth for the generator connections, and the last pair for the generator field.

Controller Rack

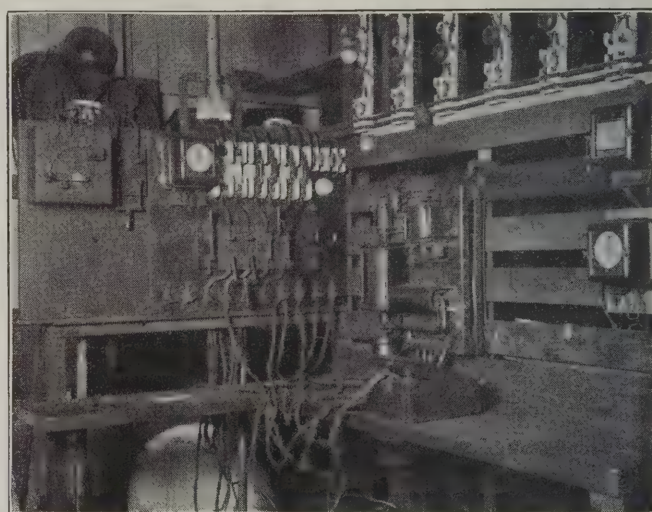
At right angles to the switchboard is a frame work and bench supported on 2-in. angle iron. Having the switchboard and test rack at right angles facilitates testing because one man can handle the switches and watch the action of the meters and apparatus at the same time. About 6 in. above the bench, a 1-in. angle-iron is mounted on the upper edge of a 2-in. by 4-in. board in such a way as to hold the bottom of a controller panel, the upper end of which is held to the rack by screw clamps. Ampere-hour meters may also be mounted in place on this rack for testing, as shown in the illustration.

Lamp-Bank and Meter

Mounted above this rack is a lamp-bank arrangement used as a lamp load on the equipment being tested. This bank consists of seven separate circuits separately fused and each controlled by a snap-switch, so that various loads may be used. A portable type volt-ammeter is used with this equipment and when not required at the test board is taken about the coach yards wherever required. This meter is rated at 0-3 or 0-75 volts and 0-10 or 0-100 amperes.

Motor and Battery Equipment

A 5-hp., 220-volt, d.c. motor is belt-connected to the car lighting generator. The device used for holding the generator in place consists of two vertical iron rods 1 in. in diameter and a cross-bar forced down on the generator by two handle-nuts. This arrangement is easily adjusted and is applicable to the various types of generators, without any changes or the use of anchor-bolts. A hand-operated traveling crane, the track for which is supported



Equipment Used in Testing Car Lighting Generators and Regulating Panels

from the ceiling, operates from the center of the shop to a point over the device used to hold the generator. By means of this crane generators are handled easily while being tested or repaired.

The battery equipment consists of 16 cells of battery similar to those on a car in service and is housed in special battery boxes located outside of the shop. This battery is given a frequent charge to keep it in condition for testing controllers and ampere-hour meters.

Summary

This testing apparatus was developed especially for rapid testing such as is necessary in a busy coach yard. Frequently trouble develops on controller panels, ampere-hour meters or generators that must be located and repaired in the course of a few hours. With the apparatus described the actual road operating conditions may be practically duplicated and the trouble remedied at once. In one particular case, a coil on an automatic switch had been causing intermittent trouble, but with the panel in the car the most exacting tests failed to locate the trouble. Having placed the controller panel on the test rack and bringing up the speed of the generator gradually, at the same time jarring the panel, the defective insulation was soon located.

The fifty-million-dollar government Railway in Alaska has involved some very heavy work. The line is not expected to pay until the land it traverses has been fully developed, as well as the ocean port. The most important bridge is that over the River Susitna, 264 miles north of Seward.

Summary and Forecast of Heavy Electric Traction

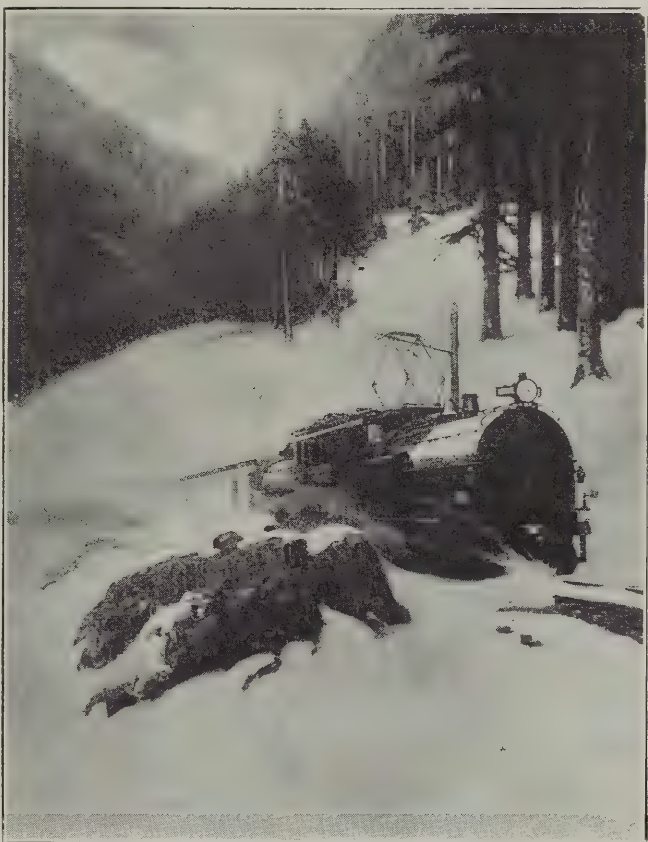
Reasons for Its Adoption in Existing Systems Are Potent Arguments for Great Future Extension

THAT the electrification of steam railroads will proceed with great rapidity during the next decade is an observation the truth of which is not difficult to concede in the light of the present day economic conditions.

The past ten years have been a period of development for the electric locomotive and while it may not be that the present designs are the utmost that engineering skill can devise, it is equally true that this motive power unit is not in the experimental stage. The electric locomotive has plainly demonstrated that it possesses inherent characteristics which are rapidly forcing recognition from superintendents of motive power on every road where heavy grades present a constant obstacle to the movement of traffic.

The cost of changing any line over from steam to electric operation is so great that it is easy to understand why so many roads feel that they cannot afford to do it. On the other hand, a careful consideration of all factors involved may easily show that some roads cannot afford not to electrify. The great difficulty arises from the fact that many savings effected by electrification are intangible and cannot be reduced to figures for comparison. There are, nevertheless, many other factors which are not intangible and which are demonstrating in daily practice that electric motive power is and is to be the greatest single factor in the intensive development of railway facilities during the next few years. Some of the reasons why electrification must be adopted are as follows:

1. The coal problem.
2. The development of hydro-electric power plants.
3. The inevitable growth of traffic.
4. The problem of increasing capacity of the present trackage due to the high cost and great difficulty of increasing present track facilities. The cost of increasing track facilities in terminals, cities and tunnels is practically prohibitive and in mountain sections, enormously expensive.
5. The ability to operate heavier tonnage trains through electrical operation, than by steam.
6. The tendency for municipalities to compel steam railroads to electrify in order to eliminate the smoke and noise nuisance in terminals, cities and tunnels.



Winter Conditions Increase Electric Locomotive Capacity

Although the coal problem in the United States is important, it has not yet reached a point where it takes on the same serious aspect as it does in many foreign nations. Some foreign countries possess such a large amount of unused water power that the most extensive plans have been made for electrification purely as a matter of economy. There are other countries, however, where the coal problem is so acute that electrification is almost imperative.

The time will unquestionably come when the roads of the United States will consider electrification of steam railroads from a purely economical standpoint. However, there are other factors which are so important that electrification will not be determined solely from this standpoint. There are many sections of steam railroads throughout the United States and Canada where present track facilities are not adequate to handle the normal amount of traffic efficiently. In some cases perhaps the cost of increasing track facilities will not be prohibitive, but in many others electrification will be the only sound solution of the problem.

In addition to the fact that it is essential for some steam railways to increase the capacity of their present trackage, the smoke and noise nuisance in terminals, cities and tunnels has stirred public opinion to the point where the municipalities are tending to compel electrification. As an illustration may be cited the case of the Illinois Central Railway at Chicago. This road made an agreement with the City of Chicago to start the electrification in that city within a specified time and to complete it within a certain number of years. Even though the Illinois Central is Chicago's greatest offender in the smoke nuisance matter, there is no question but that all other steam railways within the City of Chicago must eventually electrify.

The report of the staff of engineers who have been making a survey of the superpower zone possibilities indicates that very great savings can be effected by the electrification of portions of eleven railroads which lie

within the superpower zone. The substance of this report is given on page 409 of the *Railway Electrical Engineer* for November, 1921. It is estimated that the Class I roads which lie within this territory can be electrified at a cost of approximately $800,000,000, which with salvage would be reduced to $650,000,000.

Although it is apparent that a number of foreign countries are becoming very active in their electrification work, due to the fact that their problems have become extremely acute, it is true that the United States has done very little along this line during the past year. This is probably due to the peculiar railway situation from which we are just emerging. The stringent financial situation in which practically all of the roads have found themselves is beginning to ameliorate and there is reason to look forward hopefully to an extensive electrification program in the not far distant future. At this time it is difficult to visualize any universal electrification plan, but there are sections of certain roads where increased capacity must be brought about to handle the normal traffic. This, together with terminals and tunnels, are the problems which must be solved in the very near future and their solution will most certainly call for electrification work on a much greater scale than has ever been attempted in this country.

Projects Pending in the United States

The projects which are apparently nearest to realization are the Chicago terminal electrification of the Illinois Central Railroads, the final link of the Chicago, Milwaukee & St. Paul from Avery, Idaho, to Othello, Washington; the Delaware, Lackawanna & Western Railroad in the vicinity of Scranton, and the Altoona electrification of the Pennsylvania Railroad.

The electrification of the Illinois Central Railroad is of such a nature as to call for a tremendous amount of preliminary work before it is possible to do anything directly pertaining to the installation of electric motive power. This preliminary work is well under way at the present time.

The plans of the Delaware, Lackawanna & Western Railroad take into consideration the electrifying of the mountain grades east and west of Scranton, Pa. Bids have been published for seven freight electric locomotives, but up to the present time the contract has not been awarded. The exact mileage which is planned to electrify extends from Gouldsboro, which is 21 miles east of Scranton, to Clark's Summit which is seven miles west of Scranton. In addition to this 28 miles of main line, some of which has three tracks, there will probably be a very considerable amount of yard track in the vicinity of the city of Scranton which will also be electrified.

Although no plans have been made public concerning the electrification of any other part of the Lackawanna, the congested suburban traffic conditions at the eastern terminal of the road are such that the electrification is ultimately inevitable. At present the company is engaged in elevating its track through East Orange, N. J., and when this work has been completed, it is almost a certainty that electric operation will rapidly follow.

The electrification of the portion of the Pennsylvania line lying between Altoona and Johnstown, Pa., has been under consideration for a number of years. The distance between these two points could be very materially lessened by the adoption of electric power, which would permit a number of cut-offs to be made. Under present operation, trains must travel circuitous routes in order to minimize the mountain grades which even under these conditions present a most discouraging slow down to heavy trains. Under steam operations a shorter route would not be possible as the resulting grades could never be negotiated by a steam locomotive hauling a train.

Among other electrification projects which have been suggested but concerning which no definite plans have been made public are, the Virginian Railway, Pennsylvania Railroad (Pittsburgh district), Erie Railroad (Suburban traffic out of Jersey City), New York, Ontario & Western (suburban traffic out of Weehawken), Baltimore & Ohio (Cumberland Division), Cleveland Terminal electrification, and the Great Northern.

Projects Pending in Foreign Countries

The following table indicates the number of route miles of railroad electrification in European countries in operation, under construction and proposed:

Route Miles

	In operation	Under construction	Proposed
Sweden	300	125	1,000
Norway	60	50	500
Germany	400	100	1,500
Austria	200	...	1,000
Switzerland	250	275	1,000
Italy	600	...	3,000
France	50	...	6,000
England	200	...	1,000
Holland	50	...	600
Belgium	...	...	500

There is much activity in European railway electrification at the present time. European railroads are even harder pressed than those in the United States by financial difficulties and labor troubles, but in spite of this they are going ahead with extensive programs in electrification involving the expenditure of millions, due to the fact that fuel is high-priced and difficult to obtain.

Electrification Plans of France

The electrification program of France which has already been commenced involves the application of electric motive power to approximately 6,000 miles of main lines, mostly double track, during the next 15 years. To meet this demand for electrical energy, power plants and high tension transmission lines of the first magnitude will be required.

The extreme urgency of adoption of electric motive power is reflected in the attitude of some of the French engineers who have gone so far as to promulgate a tentative program involving electrification of over 1,200 miles of main line per year and putting into service not less than 400 new electric locomotives every year. Financial considerations will make such a program impossible but the more conservative one of electrifying 6,000 miles within fifteen years will involve buying between 200 and 300 electric locomotives per year which is a bigger project than has yet been undertaken in any other country.

Italy

The electrification of the Pinerolo-Bricherasió-Torre Pellice & Bricherasió Barge lines, 18.6 miles, will be shortly completed. This is a continuation of the Torino-Pinerolo already electrified.

The new work for extending electric traction in Italy provides for the electrification of about 2,800 miles of state railroads.

The table following indicates the electrified railway lines now in operation in Italy.

Railroad	Route	Miles, total single track	System of electrification
Lecco-Colico-Sondrio	65.45	76.2	3,400 V. 3 phase
Lecco-Monza	23.2	39.7	3,400 V. 3 phase
Milano-Varese-P Ceresio	45.25	90.7	650 V. D. C.
Torino-Bussoleno-Modane	64.9	110.	3,900 V. 3 phase
Torino-Pinerolo	23.	37.9	3,700 V. 3 phase
Savona-Ceva	28.65	43.4	3,700 V. 3 phase
Ronco-Vivio Bivarolo (via Bussalla)	16.9	49.6	3,700 V. 3 phase
Genova B-S Pierdarena	19.7	57.5	3,700 V. 3 phase
S. Pierdarena-Savona	24.8	31.8	3,700 V. 3 phase
Torino-Chieri	13.4	19.4	3,700 V. 3 phase
Bussaleno-Susa	4.7	5.2	3,700 V. 3 phase
Total	329.95	561.4	

Switzerland

The fact that Switzerland is dependent upon the good will of foreign countries for coal is the primary reason for deciding on a program for the electrification of all the lines of the Swiss Federal railroads.

The principal arteries of the Swiss railway system are government owned. The electrification on these lines is simplified by the amount of unused water power which the country possesses.

Of the 1,416 miles of railway owned by private companies, 622 miles are already electrified, but only an insignificant percentage of the government roads are at present operated by electricity. The table following lists the Swiss Federal roads now electrically operated and those of which the work of electrification is already in progress.

Lines Electrically Operated

Lines	Length of line	Year operation was started	Kind of power used
Brig-Iselle (Simplon tunnel)	13.7 miles (single track)	1905	3-phase, 3,000-volt, Freq., 16⅔
Brig-Sitten	35 miles (partly double track).	1919	As above
Thun-Born	20 miles (double track)	1919	Single phase 15,000-volt, Freq., 15
Erstfeld-Biasca	56 miles (double track)	1920	As above, but Freq. 16⅔
Biasca-Bellinzona	12.5 miles (double track)	1920	As above

Lines Being Electrified

Lines	Length of line	Time work will be finished	Kind of power used
Bellinzona-Chiasso	34 miles (double track)	End 1921	Single phase, 15,000-volt, Freq., 16⅔
Erstfeld-Lucerne	37.3 miles (partly double track).	Apr. 1922	As above
Goldau-Zug	12 miles (single track)	Apr. 1922	As above
Lucerne-Zug-Zuerich	28.3 miles (partly double track).	End 1922	As above
Sitten-Lausanne	60 miles (double track)	Aug. 1923	As above

Austria

On July 23, 1920, a bill passed the Austrian National Assembly which authorized the electrification within a period of seven years of 405 miles out of 2,780 miles of railway lines administered by the Austrian government. This bill provides for the expenditure of a sum not to exceed 5,096,000 kronen (ten million dollars).

The bill further contemplates in a second period of seven years the electrification of an additional 706 route miles of the Austrian State Railway.

Portugal

The Companhia-Sintra-Atlantico of Lisbon is proposing the construction of an electric railway from Sintra to Esterhil-Vascaes & Boca to Inferno.

Spain

Early in 1921, the Spanish Northern was asking for bids for materials to electrify a portion of its line. The first part of the road to be electrified consists of about 40 miles of the Leon Gijon line, running through the mountains between Ujo and Busdongo. The Spanish branch of the International General Electric Company is handling this project. See *Railway Electrical Engineer,* December, 1921, page 481.

South Africa

The South African Government railways are about to begin the electrification of two sections of the system and tenders are now being invited for powerhouse equipment and rolling stock. The lines to be electrified immediately are:

The Cape Town-Simonstown, Suburban Line, 22 miles long. Durban-Pietermaritzburg of the Natal main line, 70 miles long.

In the spring of 1920, the South African railroads took under consideration an electrification plan which would enable the more conjested portions of this line to meet the increase in traffic. The proposed plans contemplated an increase of traffic at 50 per cent over the electrified portions with the present trackage. Four portions of the line are considered, which involves 860 route miles, a total trackage, including yards, sidings, etc., of 1,219 miles.

Brazil

The concluding shipments are being made on the two million dollar contract with the International General Electric Company for the electrification of the section of the Paulista Railway in Brazil. This project includes a double track section eight miles in length, between Jundiahy and Compians.

This line is a main line section connecting at the south terminus with the Sao Paulo Railway and the Central Railway of Brazil. The Central Railway is government owned and electrification of this line has also been authorized.

Chile

The Chilean State Railways have had under consideration for some time the electrification of the line from Valparaiso to Santiago, a distance of 116 miles. This work has been finally contracted for by the Westinghouse Electric International Company, the amount of the contract being $7,000,000. Chile is a mountainous country, and the consequent heavy grades naturally suggested the advisability of electrification. The installation mentioned will undoubtedly result in more electrification work in that country.

Argentine

According to a report from the American ambassador at Buenos Aires, the Central North Argentine is having a study made with a view of electrifying its lines from Corooba to Cruz del Eje, a distance of 93 miles.

Philippines

The Manila Railway Company is planning the electrification of its lines, according to information made public by the Philippine Government Commercial Agency in June, last year.

Jamaica

In the summer of 1919, the government of Jamaica was reported as arranging to have a survey made of the

water power of the large rivers to see if electrification of the railways is feasible.

Japan

A little more than a year ago the Japanese government had under consideration a project of establishing an electrical power supply for railways and to gradually convert steam railroads to electric.

A recent large order indicates clearly the trend of Japanese ideas concerning the development of electric energy.

Automatic Train Control Proposed for 49 Roads

Interstate Commerce Commission Orders Carriers to Show Cause Why Installation Should Not be Required by July 1, 1924

THE Interstate Commerce Commission on January 10 served upon 49 railroads an order to show cause by March 15 why it should not adopt a report and enter an order requiring them to install by July 1, 1924, between designated points in their main lines, automatic train stop or train control devices complying with specifications and requirements set forth in the order which the commission has determined upon as the result of its investigation conducted pursuant to section 26 of the interstate commerce act.

The device, according to the proposed order, is to be applicable to or operated in connection with all road engines running on or over at least one full passenger locomotive division included in the part of the main line between the points named. It further provides that each carrier named shall submit to the commission complete and detailed plans and specifications prior to the installation and that by July 1, 1922, they shall file complete and detailed plans of the signal systems in use and a report of the number and type of locomotives assigned to or engaged in road service on the designated portions of line and shall proceed diligently and without unnecessary delay to select and install the devices as specified. They are also to file with the commission on or before July 1, and each three months thereafter full and complete reports of the progress made with the preparation for and the installation of the devices, which together with the manner and details of the installation shall be subject to the approval of the commission or the division of the commission to which the matter may be referred.

Report of the Commission

An abstract of the report of the commission says:

This is a proceeding initiated by us under Section 26 of the interstate commerce act under which we are authorized after investigation to order any carrier by railway subject to the act to install automatic train-stop or train control devices or other safety devices.

Under Public Resolution No. 46, approved June 30, 1906, the Congress directed us to investigate and report on the use of and necessity for block signals for automatic control of railway trains in the United States. The sundry civil appropriation act, approved May 26, 1908, contained a provision directed to the same end and appropriated some fifty thousand dollars for the purpose. Under the above resolution the Block Signal and Train Control Board was created and was employed by the commission from 1907 to 1912 to study the subject and to investigate numerous automatic train-stop and train-control devices presented by various designers and patentees. Reports of these investigations have been made to us with recommendation as to specifications and requirements. Since 1912 the commission's Bureau of Safety has continued these investigations. Under the United States Railroad Administration investigations were made by a special Automatic Train-Control Committee and further specifications and requirements were recommended. The records and files of this committee have been transferred to this commission.

Investigation Has Proved Worth

The conclusions arrived at as a result of these several investigations conducted from 1906 to 1920, were identical in substance, namely, that automatic control of trains is practicable; that the use of automatic train control devices is desirable as a means of increasing safety and that the development of automatic train-control devices had reached a stage warranting installation and use of such devices on a more extended scale. The results of these investigations and the conclusions thereon were published from time to time and attracted widespread attention commensurate with the importance of the subject. The successive investigations with their satisfactory results, and the recognized obvious need for some such device resulted in the inclusion in the transportation act of 1920 of a section which places upon us the duty after investigation of ordering the installation by the carriers, in locations designated by us, of automatic train-stop or automatic train-control devices which comply with prescribed specifications and requirements.

Savings From Safety

The matter of cost is the basis upon which the carriers have raised objections to an order requiring the installation of automatic stop or train-control devices. Like objection has been made to the installation of all other safety devices which are now in use and which have long since demonstrated their practicability and necessity. This objection has been raised in prosperous as well as in non-prosperous years. Yet the compensation from a financial standpoint, which will result from the securing added safety in train operations should not be overlooked. In the hearings before the Committee on Interstate and Foreign Commerce when Section 26 was under consideration certain statistics gleaned from our accident reports were presented showing that from 1909 to 1917, both inclusive, there were 13,339 head-on and rear-end collisions resulting in damage to railroad property alone of over nineteen million dollars. These collisions resulted in death to 2,454 persons and injury to 37,724. In other words, the annual average of these collisions amounted to 1,482, the average number of killed to 272, and of injured to 4,191. During the two and one-half years from January 1, 1918, to June 30, 1920, inclusive, there were 3,226 such collisions, resulting in the deaths of 635 persons and injury to 6,240.

Practicable and Necessary

The fourteen years of investigation and study, the service tests under varying conditions and the results obtained in the actual employment of these devices over periods of years upon some of the roads have clearly demonstrated the practicability of and the necessity for automatic train-stop or train-control. The time has now arrived when the carriers should be required to select and install such device or devices as will meet our specifications and requirements.

We have decided not to limit by our order the installation of these devices to roads or parts of roads already equipped with automatic block signals, because we have no desire to discourage efforts for automatically controlling trains without the aid of the fixed wayside signals.

The Roads Affected

The list of railroads to which the order was issued and the parts of their lines designated is as follows:

Atchison, Topeka & Santa Fe, between Chicago and Newton, Kan.
Atlantic Coast Line, between Richmond, Va., and Charleston, S. C.
Baltimore & Ohio, between Baltimore and Pittsburgh.
Boston & Albany, between Boston and Albany.
Boston & Maine, between Boston and Portland, Me.
Buffalo, Rochester & Pittsburgh, between Rochester and Butler, Pa.
Central Railroad of New Jersey, between Jersey City and Scranton.
Chesapeake & Ohio, between Richmond, Va., and Clifton Forge, Va.
Chicago & Alton, between Chicago and Springfield, Ill.
Chicago & Eastern Illinois, between Chicago and Danville, Ill.
Chicago & Erie, between Chicago and Salamanca, N. Y.
Chicago & North Western, between Chicago and Omaha.
Chicago, Burlington & Quincy, between Chicago and Omaha.
Chicago, Indianapolis & Louisville, between Chicago and Louisville, Ky.
Chicago, Milwaukee & St. Paul, Between Chicago and St. Paul.
Chicago, Rock Island & Pacific between Chicago and Rock Island, Ill.
Chicago, St. Paul, Minneapolis & Omaha, between Minneapolis and Omaha.
Cincinnati, New Orleans & Texas Pacific, between Cincinnati and Knoxville, Tenn.
Cleveland, Cincinnati, Chicago & St. Louis, between Cleveland and St. Louis.
Delaware & Hudson Company, between Wilkes-Barre, Pa., and Albany.
Delaware, Lackawanna & Western, between Hoboken and Buffalo.
Erie Railroad, between Jersey City and Buffalo.
Galveston, Harrisburg & San Antonio, between El Paso, Texas, and Houston.
Great Northern, between St. Paul and Minot, N. D.
Illinois Central, between Chicago and Memphis.
Kansas City Southern, between Kansas City and Texarkana, Texas.
Lehigh Valley, between Jersey City and Buffalo.
Long Island, between Jamaica and Montauk.
Louisville & Nashville, between Louisville and Birmingham.
Michigan Central, between Chicago and Detroit.
Missouri Pacific, between St. Louis and Kansas City.
New York Central, between Albany and Cleveland.
New York, Chicago & St. Louis, between Chicago and Cleveland.
New York, New Haven & Hartford, between New York and Providence, R. I.
Norfolk & Western, between Roanoke, Va., and Columbus, Ohio.
Northern Pacific, between St. Paul and Mandan, N. D.
Oregon-Washington Railroad & Navigation Company, between Portland and Pendleton.
Pennsylvania Railroad, between Philadelphia and Pittsburgh.
Pere Marquette, between Grand Rapids and Detroit.
Philadelphia & Reading, between Philadelphia and Harrisburg.
Pittsburgh & Lake Erie, between Pittsburgh and Youngstown, O.
Pittsburgh, Cincinnati, Chicago & St. Louis, between Pittsburgh and Indianapolis.
Richmond, Fredericksburg & Potomac, between Washington and Richmond, Va.
St. Louis & San Francisco, between St. Louis and Springfield, Mo.
Southern Pacific Company, between Oakland and Sacramento.
Southern Railway Company, between Washington and Atlanta, Ga.
Union Pacific, between Omaha and Cheyenne.
West Jersey & Seashore, between Philadelphia and Atlantic City.
Western Maryland, between Baltimore and Cumberland, Md.

Specifications and Requirements for Automatic Train-Stop or Train-Control Devices

The definitions, functions, requirements and specifications governing the installation and operation of automatic train-stop or train-control devices prescribed are given in the appendix as follows:

Purpose.

The purpose of this general specification is to define automatic train-stop or train-control devices and to outline essential features involved in their design, construction and installation on railroads.

Definition of Automatic Train-stop or Train-control Devices.

A system or installation so arranged that its operation will automatically result in either one or the other or both of the following conditions:

First—Automatic Train-stop—The application of the brakes until the train has been brought to a stop.

Second—Automatic Speed Control—The application of the brakes when the speed of the train exceeds a prescribed rate and continued until the speed has been reduced to a predetermined and prescribed rate.

Functions.

In prevailing practice the primary function of automatic train-stop or train-control devices is to enforce obedience to the indications of fixed signals; but the feasible operation of essentially similar devices used without working wayside signals may be regarded as a possibility. The following features may be included, separately or in combination, in automatic train-stop or train-control systems:

1. Automatic Train-Stop.
   Without manual control by the engineman, requiring the train to be stopped; after which they apparatus may be restored to normal condition manually and the train permitted to proceed.
2. Automatic Train Control or Speed Control.
   (a) Automatic stop, after which a train may proceed under low-speed restriction until the apparatus is automatically restored to normal or clear condition by reason of the removal of the condition which caused the stop operation.
   (b) Low-speed restriction, automatic brake application under control of the engineman who may, if alert, forestall application at a stop indication point or when entering a danger zone and proceed under the prescribed speed limit, until the apparatus is automatically restored to normal or clear condition by reason of the removal of the condition which caused the low-speed restriction.
   (c) Medium-speed restriction, requiring the speed of a train to be below a prescribed rate when passing a caution signal or when approaching a stop signal or a danger zone in order to forestall an automatic brake application.
   (d) Maximum-speed restriction, providing for an automatic brake application if the prescribed maximum speed limit is exceded at any point.

General Requirements.

1. An automatic train-stop device shall be effective when the signal admitting the train to the block indicates stop, and so far as possible when that signal fails to indicate existing danger conditions.
2. An automatic train-control or speed-control device shall be effective when the train is not being properly controlled by the engineman.
3. An automatic train-stop, train-control or speed-control device shall be operative at braking distance from the stop signal location if signals are not overlapped, or at the stop signal location if an adequate overlap is provided.

Design and Construction.

1. The automatic train-stop or train-control device shall meet the conditions set forth under general requirements applicable to each installation.
2. The apparatus shall be so constructed as to operate in connection with a system of fixed block or interlocking signals, if conditions so require, and so inter-connected with the fixed signal system as to perform its intended function;
   (a) In event of failure of the engineman to obey the signal indications; and
   (b) So far as possible, when the signal fails to indicate a condition requiring an application of the brakes.
3. The apparatus shall be so constructed that it will, so far as possible, perform its intended function if an essential part fails or is removed, or a break, cross or ground occurs in electric circuits, or in case of a failure of energy.
4. The apparatus shall be so constructed as to make indications of the fixed signal depend, so far as possible, upon the operation of the track element of the train-control device.
5. The apparatus shall be so constructed that proper operative relation between the parts along the roadway and the parts on the train will be assured under all conditions of speed, weather, wear, oscillation and shock.
6. The apparatus shall be so constructed as to prevent the release of the brakes after automatic application until the train has been brought to a stop, or its speed has been reduced, to a predetermined rate, or the obstruction or other condition that caused the brake application has been removed.
7. The train apparatus shall be so constructed that, when operated, it will make an application of the brakes sufficient to stop the train or control its speed.
8. The apparatus shall be so constructed as not to interfere with the application of the brakes by the engineman's brake valve or to impair the efficiency of the air brake system.
9. The apparatus shall be so constructed that it may be applied so as to be operative when the engine is running forward or backward.
10. The apparatus shall be so constructed that when two or more engines are coupled together, or a pushing or helping engine is used, it can be made operative only on the engine from which the brakes are controlled.
11. The apparatus shall be so constructed that it will operate under all weather conditions which permit train movements.
12. The apparatus shall be so constructed as to conform to established clearances for equipment and structures.
13. The apparatus shall be so constructed and installed that it will not constitute a source of danger to trainmen, other employees or passengers.
14. The apparatus shall be so constructed, installed and maintained as to be safe and suitable for service. The quality of materials and workmanship shall conform to this requirement.

Electrical Progress During the Past Year

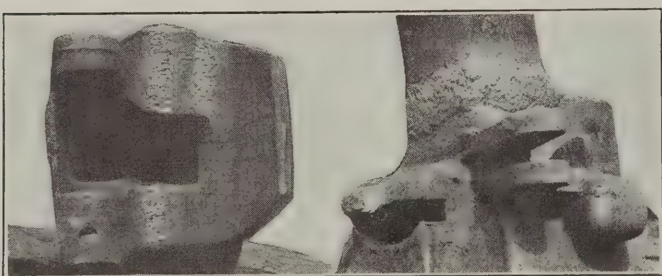
Applications of Electric Energy Point Out Its Ever Increasing Usefulness in Railroad Operation

ELECTRIC arc welding during the past year has been used succesfully in repairing a considerably greater variety of parts than ever before. Some of the more recent applications are listed in the table:

Applications of Electric Arc Welding.

1. Cast Steel Wheel Centers.
2. Cast Iron Wheel Centers.
3. Application of Hub Liners.
4. Building Up Tires on Wheels.
5. Couplers.
6. Coupler Knuckles.
7. Truck Sides and Bolters.
8. Draft Castings and Car Sills.
9. Side Plates and End Plates.
10. Building Up Worn Crossings, Frogs and Switches.
11. Erecting Iron and Steel Structures, Including Tanks.

The table lists only a small part of recent applications and is presented to show the trend in the use of arc welding. Few roads use all of the practices listed, but it will probably be only a matter of time before they will be used generally.



A Triple Electric Weld in the Face of a Coupler and a Welded Coupler Shank

Large savings can be made by the use of autogenous welding, both electric and gas, and that will, of course, cause its use to be extended as rapidly as the users can learn how to obtain dependable welds. It has been shown that an investment of $150,000 in welding equipment on the Chicago, Rock Island & Pacific Railway has in a few years saved three times its cost. After the practice of welding locomotive tires was established, no new tires were purchased for a period of three years, and the number now bought is only about one-third of the former average.

Electric resistance welding will probably come into much greater use than at present for safe-ending boiler tubes. The committee of the Master Boiler Makers' Association on Methods of Welding Safe Ends on Locomotive Boiler Tubes made the following statement in its last report: "Welding safe ends by the electrical welding machine, in the opinion of the committee, will eventually supersede the present method."

Rivet heating cannot be classified as welding, but as a closely allied work it should be said that electric rivet heaters have proved their economy and usefulness and are rapidly finding favor in boiler, tank and car shops.

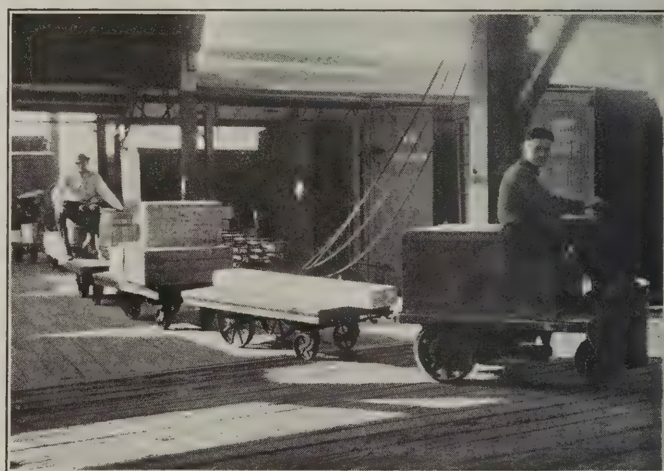
Practically all of the manufacturers of welding machinery have made improvements in their equipment. Among the outstanding development is the so-called semi-automatic welding lead which has been applied to the General Electric, automatic welder. It consists of a 10-foot length of flexible steel tubing, equipped at one end with an adapter for attaching it to the automatic head; and at the other end with a guide nozzle to direct the electrode wire to the arc. This device combines the advantages of a steady supply of wire and the constant arc length of the automatic welding head with that obtained by allowing the operator to direct the arc manually.

Several new gas engine driven welding sets have been designed for use in places where electric power is unavailable or where it is inconvenient or costly to bring it to the work.

Marked progress has also been made in percussive welding and for certain purposes it has been shown to be the quickest and most efficient method of welding.

Alloy steels have been welded successfully by the electric arc process, and with adequate mechanical and heat treatment, tensile strengths of the weld of 130,000 lbs. per square inch have been secured.

"Welding Wire Specifications and Standards for Testing Welds" have been published in pamphlet form by the American Bureau of Welding.



Electric Tractors and Trailers in Freight Transfer Service on the New Haven at Cedar Hill

Electrical Devices for Handling Material

Two new types of crane trucks were developed during the year which will probably find a wide application. These trucks have a capacity of 3,000 lb. and have a boom long enough to lift an air pump or front end into position on a locomotive. They are designed for use in engine-houses and similar places where an overhead crane is not available and have the added advantage of being able to carry material from one building to the other as for instance, from the storage platform to the repair shop.

They are being used by the Western Maryland and the New York Central and in describing their usefulness,

M. E. Tonner, general purchasing agent, Western Maryland, writes as follows:

"Electric crane trucks are being installed on a regular tour of duties, including routing through shops, with loading and unloading stations marked where material is unloaded or assembled, inclusive of tagging for delivery at distribution point. Air pumps are taken from the side of a locomotive; and in one instance the operation of taking down an air pump, delivering to repair point and bringing back an extra pump, consumed 21 minutes, as against previous one and one-half hours for the operation. Another operation was the handling of the side rods, and equally heavy material in 30 minutes as against previous four hours operation. This tour of duties includes from a one day ahead program to a 30 day ahead program. The electric crane trucks are to be operated in zones, in accordance with the amount of work to be handled within the zone.

The successful operation of tractors and trailers in freight transfer service was particularly well demonstrated by an installation on the New Haven at the Cedar Hill transfer, where 14 tractors are used. One hundred and thirty-one distinct classifications are made daily and as many as 305 cars have been worked in one day, a normal daily performance being between 260 and 285 cars. The ability of the transfer to work this number of cars, with tractors and trailers, has resulted in the closing of the transfers at Westchester and Maybrook permanently. Furthermore, approximately 80 per cent of the transfers at Bridgeport and Hartford and 50 per cent of the transfers at Waterbury, Danbury and Poughkeepsie, have been eliminated through the concentration of the transfer business on the west end of the line.

500-Kilowatt Synchronous Converters

During the past year, the largest lift and turn-over type of car dumper in the world has been installed at the docks of the Western Maryland in Baltimore. It has a capacity of unloading fifty 100-ton cars per hour.

Grain car dumpers were installed on the Pennsylvania piers at Baltimore. Four of these machines, with an operating crew of 18 men can unload 400 cars daily.

Motors and Control Devices

A remarkably large number of switches and switch controls have been developed during the year. Most of these were designed principally for the sake of safety and convenience. The old open type of switches are being rapidly displaced by those which are fully enclosed. Automatic starters have been developed for synchronous motors.

In the application of electric motors to shop machines, there have been two developments of note. One of them is the application of "built-in" high-speed induction motors to various wood-working machines, grinders and other machines which require high uniform speeds; and the other is a new form of direct-connected, reversing-motor drive for planer. The new planer drive was developed to overcome troubles caused by planers over traveling from any one of several causes.

Lighting

The most notable developments in lighting for railroad service have been in yard and enginehouse lighting. Detailed methods have been worked out by the Lighting Service Department of the Edison Lamp Works of the General Electric Company for using flood lights for night illumination of classification yards, scale houses and turntables, and these methods have been applied with excellent results.

Enginehouses are now lighted on the Boston & Albany and the Lehigh & Hudson by mounting two floodlights with crossed beams on the outer circle wall between each stall. This method does not solve all of the wiring difficulties of enginehouse lighting, but it simplifies them and supplies effective lighting. It represents a big step in the right direction.

Miscellaneous

Notable development work has been done which has greatly improved the operation of automatic substations, and a number of installations have been made during the year. These installations have all been made for power and street railway companies, but it is highly probable that such substations will soon find a place in railroad service.

Aside from the developments enumerated in the above paragraphs, much has been done in the way of developing large machinery for power development, high voltage power transmission, electric ship propulsion and wireless telegraphy, and telephony, but these subjects will not be enlarged upon as the purpose of this résumé is to include only such developments as are applicable to railroad service.

Photo from Keystone View Co., Inc., N. Y.

Wheat Field on the Huancayo Line of the Central of Peru

One Section of a C. & N. W. Enginehouse

Enginehouse Lighting Used on the North Western

Suspended Conduit and Reflectors Mounted in Pairs Are Features of Lighting System

A METHOD for lighting enginehouses which has been in use on the Chicago & North Western for several years, involves the use of two reflectors mounted on the wall between each stall on the outer circle wall and one reflector between each stall on the inner circle wall. One 7½ kva. transformer supplies power for lighting a 35-stall enginehouse. The transformer is located just outside the outer circle wall, about half way around the enginehouse. Three No. 6 wires are brought into the building from the transformer to a main control panel, mounted in a steel cabinet. There are 14 branch circuits run out from this panel, each of which is protected and controlled by a fuse cutout and knife switch. There are eight branch runs of conduit extending out from the main switch cabinet, four running in either direction. These branch runs are mounted on the outer circle wall, just above the windows, on wood blocks. Inserted in the brick work above the window frames is a block of wood to which the conduit is fastened with metal straps. Between the windows, blocks of wood are fastened to the brick wall by means of expansion bolts, and the conduit is also strapped to these blocks. The conduit and wood blocks are painted with gas proof paint, and the blocks are so arranged as to hold the conduits about one inch away from the wall. These branch runs of conduit vary in size from ½ in. to 1½ in., depending upon the number of circuits in each conduit. In most cases each circuit supplies current for lighting three stalls. One or more distribution panels in steel cabinets are used in enginehouses, depending upon the number of stalls. Rubber-covered duplex wire is used for all circuits, No. 12 or No. 14 being used, depending upon the distance of the outlets from the main control panel. Where branch runs are divided for the purpose of extending them to the lighting units or extension outlets, Crouse-Hinds No. 2222 condulets are used as junction boxes.

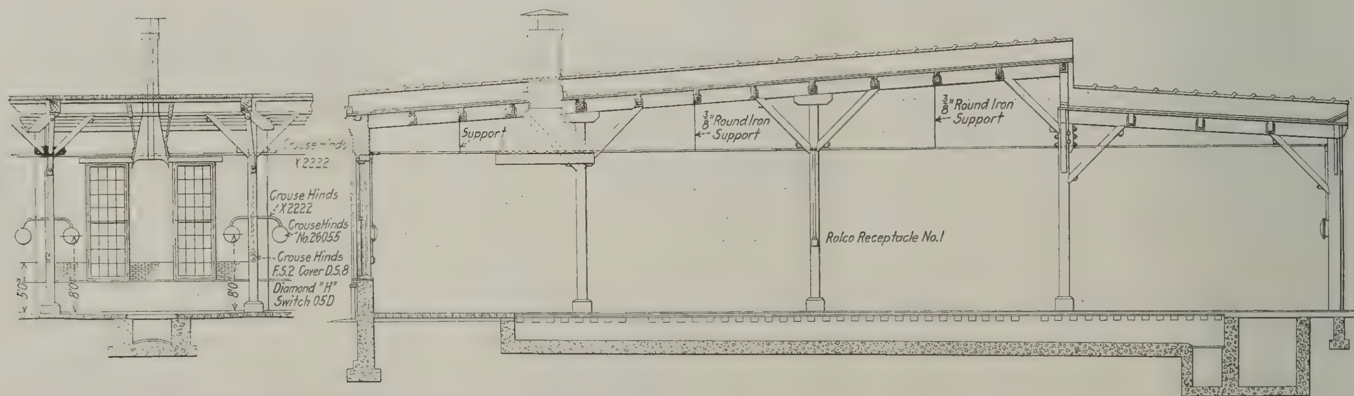


Fig. 1—Cross-Sectional Elevation Showing Location of Reflectors and Conduit

The manner in which the conduit is run to each of the pairs of lighting units on the outer circle is shown in Fig. 2. One of the two enclosed push-button switches shown in the illustration operate the two lamps on the outer circle and the other controls the single lighting unit mounted on the inner circle wall. The conduit running into the lamp on the inner circle wall is suspended by hangers made of 3/8-inch wrought iron rods, as shown in Fig. 1. A connection from this conduit run extends down the middle post to an extension receptacle. This receptacle is energized at all times except when the entire circuit is cut out by means of the switch in the main control panel.

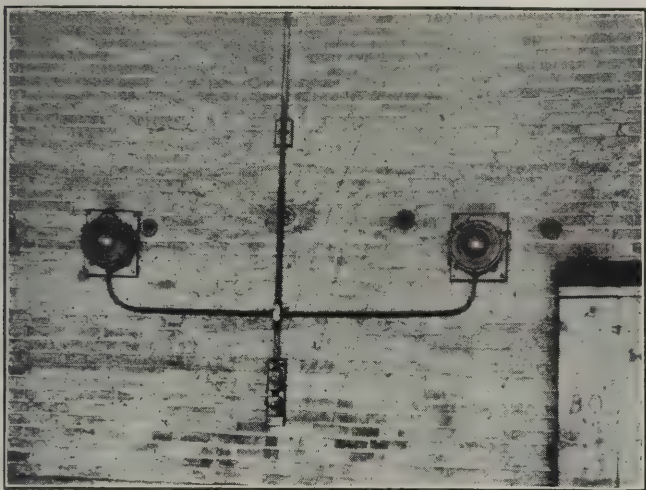


Fig. 2—The Reflectors on the Outer Circle Wall Are Mounted in Pairs at a Slight Angle to the Wall so that the Beams of Light are Crossed

The lighting units mounted on the outer circle wall are placed about 8 ft. from the floor and are so arranged that the two beams of light are crossed in the head of the stall. That is, the unit on the right throws light on the right hand side of the locomotive in the next stall to the left. The lighting fixtures selected for this service are Crouse-Hinds No. 26055 model lighting units fitted with corrugated glass lenses. Any size of lamp up to 60 watts capacity can be used in this type of reflector. The lenses in the reflector are so constructed that they will afford illumination at a considerable distance from the unit. It also has two edge rims which serve to distribute light immediately in front of the lens. This local distribution of light is provided for lighting the runways and for locating tools, etc., that are often placed near the wall of the roundhouse.

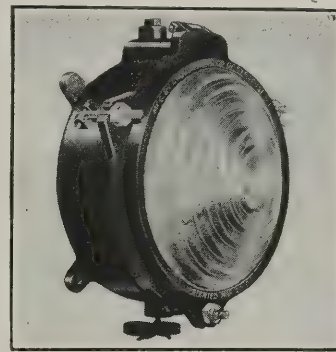


Fig. 3—The Type of Reflector Used for Enginehouse Lighting

Wheel drop pits and the jack runways between them are equipped with electric lights mounted in Crouse-Hinds type V-H condulet fittings. This type of fitting was selected due to its water proof and lamp protective construction. These lamps are allowed to burn constantly for they act as a safety device by allowing the light to show through in case any of the planking or covering of these runways is left off or out of place. The turntable circle is lighted by four 14-inch flat cone reflectors; each unit being controlled by a switch. The bulletin boards for roundhouse employees, engineers and firemen are lighted by angle reflectors.

Photo by Underwood & Underwood.

Railway Station at Melbourne, Australia

Fuse Protection for a Volt-Ammeter

When using a portable type volt-ammeter for testing it sometimes happens that the low reading ammeter scale is inadvertently connected across the battery voltage; as a result the instrument may be seriously damaged. To prevent such a disaster, another terminal post may be installed which is connected to the + post of the meter by a fuse wire. The capacity of the required fuse depends on the meter, but a 3-ampere fuse is recommended. When taking higher ampere readings this fuse will of course be bridged, but the instrument is protected for all other readings.

Unusual Pipe Bending Device

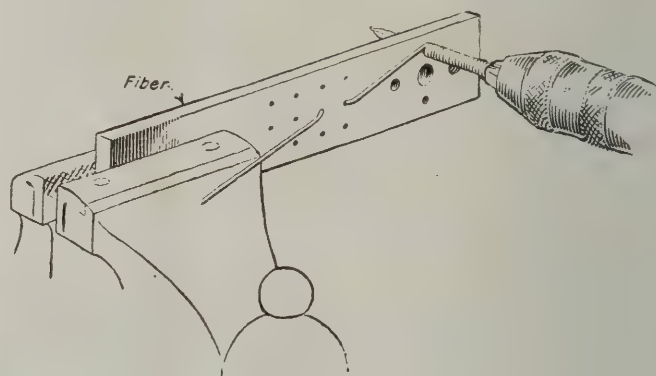
A novel means of bending pipe is shown in the photograph below, which, according to Railway and Locomotive Engineering, is used at one of the shops of the Norfolk & Western Railway at Roanoke, Va. The device consists of a single casting made in successive cylindrical steps, each cylinder having a smaller diameter as the stack increases in height. On one side of the casting a series of loops are formed. These loops, which somewhat resemble the handle of a cup, are made in different sizes in order to accommodate pipes from 1 in. to 2½ in. in diameter. The casting is firmly secured with lag screws to the upright ends of heavy timbers at a height which is most convenient for the work of bending pipe. In using the device one end of the pipe is simply pushed into the proper loop, while the other end is easily carried around the cylinder, thereby making a bend of any desired angle.

This Device is Suitable for Bending Pipes from 1 in. to 2½ in. in Diameter

---

How to Make Spiral Springs

When small spiral springs of various appliances break or lose their qualities it is not a very difficult matter to make new ones of the required material by using a spring block as shown in the illustration. A strip of ¼-in. fibre for the spring block works best. Take a piece of fibre about 2 by 6 in. and bore four or five holes in one end, ranging in size from ⅛ to ⅜ in. Near the large holes bore several small ones, say 1/16 in. in diameter. By using nails or pieces of small rod, any size spring can be made, according to the size of the holes.



Making a Spiral Spring is a Simple Operation

Put the block in a vise and thread the spring wire through the holes to give it tension. Take a nail the size of the spring required. Cut off the head and put it into the hole where it fits best. Wrap a few turns of the wire around the nail and grip the wire and nail in an ordinary brace, as shown in the illustration. Then simply wind the wire around the nail until the desired length of spring is obtained.—*Power.*

Where the Trains Meet

"A train leaves Winnipeg," said the teacher, "traveling forty miles an hour. It is followed thirty minutes later by a train traveling 80 miles an hour. At what point will the second train run into the first?"

The class seemed at a loss; that is, all except Willie Green, who was standing in the aisle vigorously wagging his hand.

"Well Willie," said the teacher.

"At the hind end of the rear car, ma'am," answered Willie.—*New York Sun.*

Who Am I?

I am more powerful than the combined armies of the world.

I am more deadly than bullets, and I have wrecked more homes than the mightiest of siege guns.

I steal in the United States alone over $300,000,000 each year.

I spare no one, and find my victims among the rich and poor alike, the young and old, the strong and the weak.

I massacre thousands upon thousands of wage-earners in a year.

I lurk in unseen places, and do most of my work silently. You are warned against me, but you heed not.

I am relentless. I am everywhere; in the home, on the street, in the factory, at railroad crossings, and on the sea.

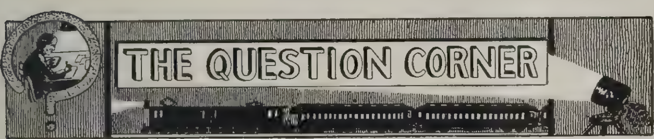
I bring sickness, degradation and death, and yet few seek to avoid me.

I destroy, crush and maim; I give nothing, but take all.

I am your worst enemy.

I AM CARELESSNESS.

—*Long Island R.R. Magazine.*



Answers to Last Month's Questions

1. *Can you tell me why it is that large knife-switches designed for carrying currents of over 2,000 amperes have a different capacity rating for direct current than for alternating current?—M. M.*

2. *What is the easiest way of connecting two batteries through a switch so that they may be charged in series and discharged in parallel?—C. J. S.*

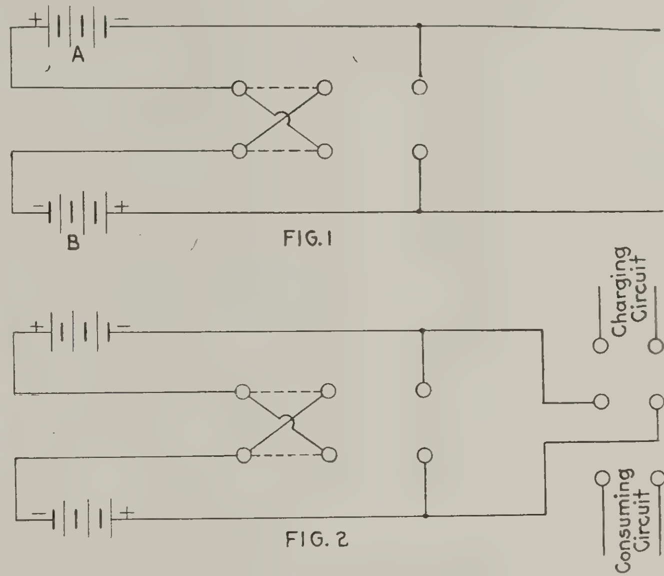
3. *Does the ampere-hour efficiency of a lead storage battery differ when charged at high and low rate?—J. E. R.*

* * *

1. In comparing the phenomena which occurs in conductors carrying alternating current with those which occur in conductors carrying direct current due consideration must be given to what is known as "skin effect." The conductor may be thought of as being composed of a large number of small filaments. In the case of direct current each of these filaments carry an equal portion of the total current. This is not true, however, when alternating current flows in the circuit, as the current is not distributed evenly throughout the cross section of the conductor. The "skin effect," which is an inherent characteristic of an alternating current circuit, is caused by the unequal counter e. m. f. throughout the cross section of the conductor. Those filaments of the conductor which are situated at the center will be surrounded by the greatest number of lines of force. As this magnetic field rises and falls with the alternations of the current it is plain that the greatest counter e. m. f. will be developed at the center of the conductor. This being true it is equally obvious that more current will flow through the outer filaments since they present a lower impedance. This condition increases the effective resistance of the conductor and points out the reason why a conductor carrying alternating current runs hotter than a conductor of the same size carrying a direct current of the same value. For switches of smaller capacities the "skin effect" is not enough of a factor to be considered but in current values above 2,000 amperes it is sufficiently important to be reflected in the dual rating of the switch.

* * *

2. Probably the easiest and most satisfactory way of connecting batteries so that they can be charged in series and discharged in parallel is by the use of a double pole, double throw knife-switch, as shown in Fig. 1. In this diagram the switch blades are indicated as being thrown



Wiring Diagrams for Connecting Batteries in Series or Multiple by Means of a Double Pole, Double Throw Switch

to the left, in which position the two batteries A and B are connected in series. By throwing the switch to the right the two batteries will be placed in parallel.

A second double pole, double throw switch, can be used to advantage sometimes when it is desirable to separate the charging and consuming circuits. This connection is indicated in Fig. 2.

* * *

3. There is little difference in the ampere-hour efficiency of a storage battery whether the battery be charged and discharged over a small part of the battery capacity or over the full capacity. The kilowatt-hour efficiency, however, is very much higher where the battery is charged and discharged over a short range frequently but without being brought to a full charge at high rate.

* * *

Questions for December

1. *Assume a battery or other direct current source, whose open circuit voltage measured with a voltmeter of very high resistance is 10 volts, and further suppose that when this same source is short circuited through an ammeter having negligible resistance the current is 10 amperes. The problem is, what is the maximum number of watts this battery can supply to an external circuit, and what is the resistance of that circuit?—W. L. B.*

NEW DEVICES

Electric Rivet Heating Devices

The increased popularity of rivet heating devices using electrical energy is everywhere in evidence and based on several important advantages. In convenience of operation, cleanliness and ready movement from place to place, the electric rivet heater surpasses any other type made. Hot rivets are provided in a few seconds and being heated from the inside, rivets are free of scale, have a uniform temperature throughout and there is a minimum number of lost and burnt rivets. On account of the fact that current is used only when rivets are being heated, the machines lose little heat by radiation and are comfortable to work around.

The rivet heater, illustrated in Fig. 1, was designed

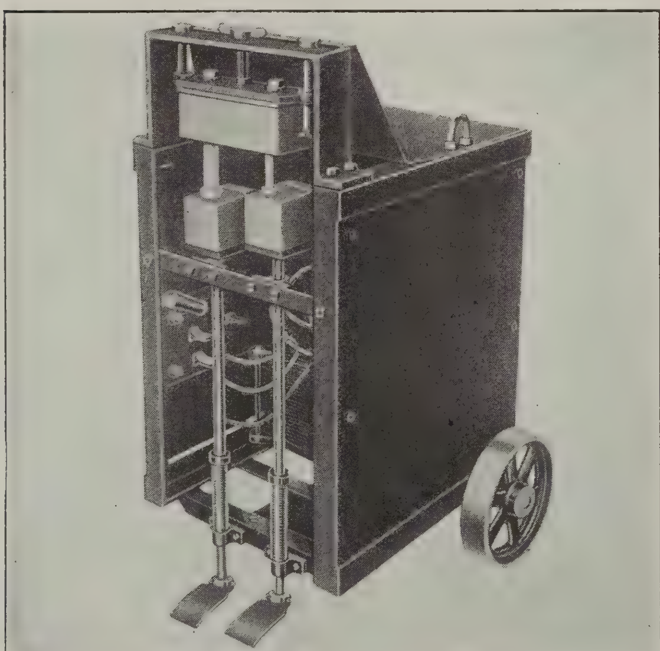


Fig. 1—United States Electric Rivet Heater Heats Rivets from ⅜ In. to 1½ In. in Diameter in Lengths up to 6 In. Without Adjustment

recently by the United States Electric Company, New London, Conn., and embodies the advantages mentioned above. It was built to meet the requirements of structural steel builders, boilermakers, car manufacturers and in fact any one who uses hot rivets from ¼ in. to 1½ in. in diameter by 6 in. long. The time for heating a rivet of the largest size is about 30 seconds.

The device is built in three types A, B and C with electrodes arranged to heat two, four or six rivets at one time. The large type C machine can heat twelve 1-in. rivets per minute which is as fast as they will ordinarily be required. Ten, 15 and 20 kw., respectively, is the

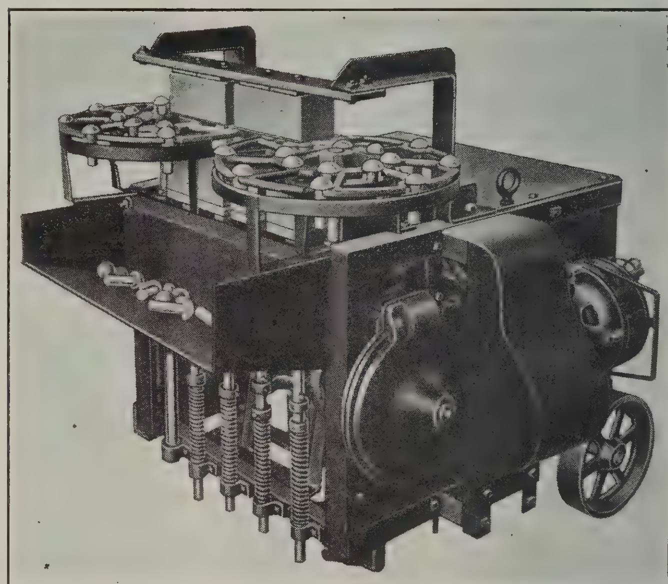


Fig. 2—Automatic Electric Rivet Heater for Use When Making Long Runs on One Size of Rivet

power consumption of the machines, depending upon the diameter of rivets to be heated.

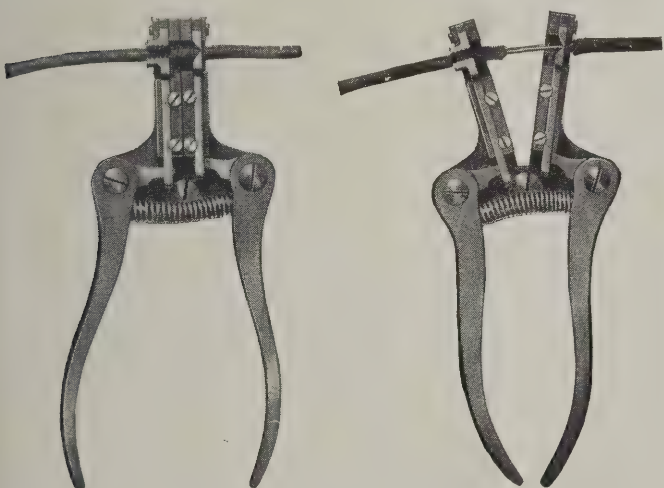
A pan is supplied with the heater when it is desired to hold a quantity of rivets in front of the operator or heater, and the rivets are easily placed by hand in the electrodes and removed with the tongs when heated. The operation is simple. The control switch being set for the size of rivets to be heated, the operator presses down on the foot lever and places a rivet between the electrodes until the desired heat is obtained. By heating in series after the first two rivets are heated, there is always a hot rivet ready for the riveter, and the operator always can control the current by removing one rivet, eliminating the pulling of a switch. The switch will be supplied if specified so that it will not be necessary to remove the rivet. The machine operates on 60 cycles and 220, 440 or 550 volts.

The automatic rivet heater, illustrated in Fig. 2, is built to heat rivets when making long runs on one size of rivet, heating as high as twelve ¾ in. by 2½ in. rivets per minute. The machine is equipped with a control switch, the horizontal rotating frames being arranged to hold any size rivet and accommodating 32 at one loading. The electrodes can be adjusted for any length of rivet up to five inches long and timed to give the desired heat in the rivet. The rivets are placed by hand into slots in a rotating circular frame by which means they are successively brought between the heating electrodes and as fast as the rivets are heated they are dropped into the receiving tray below. The temperature of the rivets is regulated by the speed of the rotating frame which is easily adjusted.

Wire Stripper

A device for stripping the insulation from the ends of wire, called the "Autopull" wire stripper, has been developed and placed on the market by Stuart G. Wood, 292 Ryerson street, Brooklyn, N. Y. The stripper is designed for use on all kinds of insulated wire up to No. 14 in size, and it is claimed that 1,250 ends can be stripped in one hour by the use of one of these tools. The device has two jaws which are opened and closed by pressure and release of the handles through the lower halves of the jaws, which slide in grooves. The jaw shown at the left is corrugated and serves only to grip the wire. The jaw at the right has a pair of cutting edges in each of which there are three V-shaped notches of different sizes.

When the insulation is to be stripped from a piece of wire, the wire is placed in one of the three notches, depending on the size of the wire. When the handles are compressed, the left hand jaw closes first, gripping the wire. When the right hand jaw closes, the cutting edges cut down almost through the insulation, but do not cut the wire, as that lies in the notch, and when the two jaws have closed, they move apart, stripping off the insulation at the end of the wire without nicking the wire.

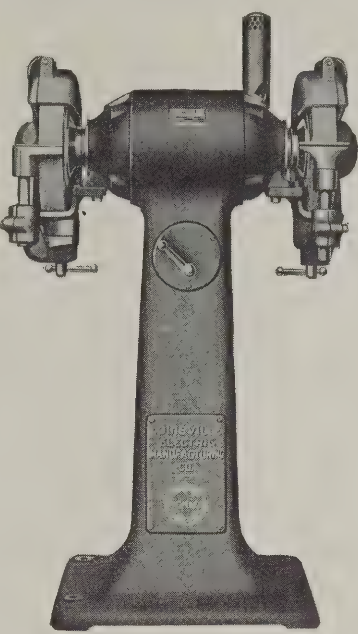


The Autopull Wire Stripper

The operation is a quick and easy one and the tool should be particularly useful in work that requires stripping off the insulation from a considerable number of small wires.

Electric Grinder

An electric grinder driven by a 2-hp. motor has been developed by the Louisville Electric Manufacturing Company, Inc., Louisville, Ky. The grinder can be furnished equipped with either an alternating or direct-current motor. Ventilating air for the motor is drawn in through an upright tube, which is of such a length that very little of the dust from the grinding can get into the motor. The motor will operate continuously with the ventilator open and the ventilator may be closed for intermittent duty. The machine is provided with ball bearings enclosed in dust-proof housings. The safety hoods are made of steel with hinged side walls so that the grinding wheels can be changed quickly and the rests are adjustable. The complete machine is of symmetrical design and is free from dirt-catching pockets so that it can be easily cleaned. The starting switch is enclosed in the pedestal.

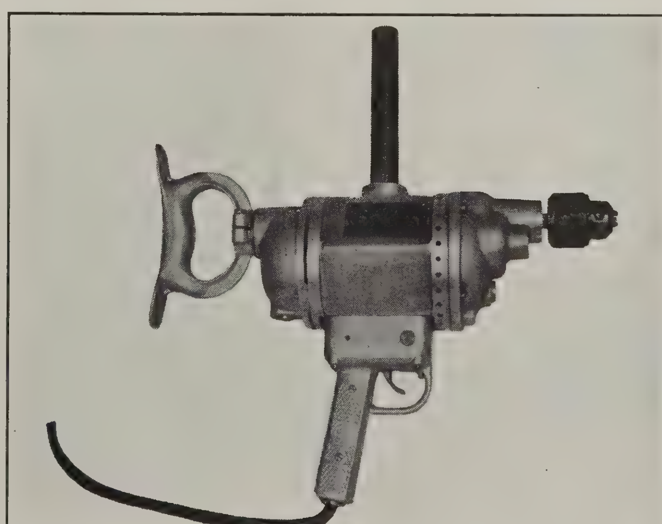


Grinder Driven by Totally Enclosed Motor With Remote Ventilating Air Intake

A Special Half-Inch Drill

A special half-inch drill embracing the pistol grip and trigger switch feature has been placed on the market by the Black & Decker Manufacturing Company, Baltimore, Md.

The housing of this new drill is of aluminum alloy. The motor used is of the universal 110-volt type, operating on either direct or alternating current, and an aluminum alloy fan keyed to the armature shaft is used for cooling.



Special Drill With Pistol Grip and Trigger Switch

General News Section

The Cutler-Hammer Mfg. Co. announces the removal of its Boston office from the Columbian Life Building to Rooms 403 and 404 Harvey Building, Chauncy street. C. W. Yerger is manager of this office.

The Signal Section of the American Railway Association is to hold its annual meeting next year on June 14, 15 and 16, at Monmouth Hotel, Spring Lake, New Jersey. Spring Lake is on the New York & Long Branch Railway, ten miles south of Long Branch and 55 miles from New York City.

The Appleton Electric Company, 1701 Wellington avenue, Chicago, Ill., on January 1, took over the business of the Anderson Electric & Equipment Company. The Appleton Electric Company will continue to manufacture the lighting fixtures and other products formerly manufactured by the Anderson Company.

The Black & Decker Mfg. Co., builders of Portable Electric Tools, announce that, effective January 3, 1922, they will make a freight allowance on shipments of 100 lb. or over to points in the United States and Canada. This will make it possible for jobbers to sell Black & Decker goods in the United States and Canada without adding anything to the price to cover freight.

Announcement of changes and transfers in personnel of the Westinghouse Electric & Manufacturing Company has been made by officials of that company. Several changes have recently been made in the railway sales department, the organization of which is now as follows: F. H. Shepard, director of heavy traction; M. B. Lambert, manager, E. D. Lynch, office manager; F. F. Rohrer, assistant to manager in charge of contracts; C. H. Long, section manager railway equipment contracts and orders; R. Seybold, manager price section; T. H. Stoffel, electric railway freight haulage export; W. R. Stinemetz, manager, and R. W. Carter, assistant manager of the heavy traction division; K. A. Simmon, manager, light traction division; J. L. Crouse, manager, and J. W. Lewis, assistant manager, railway development and supply division. H. A. Campe has been appointed manager of the small motor appliance section of the industrial department, succeeding V. M. Beeler, who has been transferred to the Springfield office. H. B. Smith has been appointed manager of the domestic service section of the department, succeeding Mr. Campe. G. L. Washington has been appointed assistant manager of the Havana, Cuba, office of the Westinghouse Electric International Company.

Electrification in the Philippines

The Manila Railroad contemplates electrification by means of power from the Agno River in Central Luzon, which is believed to possess a potential capacity of from 12,000 to 15,000 h.p., according to the Times (London) Trade Supplement.

Bids for Electrification of Brazilian Railway

The long-expected notice for sealed bids for the electrification of the Central of Brazil was recently announced, according to Assistant Trade Commissioner Embry at Rio de Janeiro. The notice calls for proposals on the electrification of stretches of the line, the supplying of traction and transport material, the construction of substations and various other improvements. The proposals will be received on March 30, 1922, at 1 p. m. A bond of 200 contos ($216,000) is exacted to guarantee the signature of the contract. After that day and following a judgment of the fitness of the competitors, a day will be set for the opening of the proposals, following which a selection will be made.

Only those competitors will be considered as fit who can prove in addition to sufficient financial capacity that they have furnished and installed other large and complete equipment for electric traction including installations for large railway yards. In order to guarantee the execution of the contract, the bond will be raised to 500 contos of reis ($540,000).

The work relating to the suburbs of Rio de Janeiro is to be concluded within a period of two years and the other works within a period of three years, both counting from the date of registry and approval by the Tribunal de Contas.

There will be three or four substations. Thirty locomotives will be furnished, 10 for freight and 20 for passenger service. For the suburban service, 66 electric cars (carros motores) will be acquired, composed of 60 first-class cars and 6 second class.

Japan Places Large Order for Transformers

Work has been started at the plant of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., on the largest single order for electrical transformers ever placed, according to announcement made by officials of that company. The order was received by the Westinghouse Electric International Company, through its Japanese agents, Takata & Company, from the Daido Denrioku K.K. (The Daido Electric Power Company of Japan).

The contract calls for 34 transformers, averaging 9,400 kva. each, a total of 316,400 kva. The transformers will be single phase, 60-cycle, oil insulated and water-cooled, and will have a high voltage of 154,000 volts, which is the highest voltage in commercial use at this time. When installed, they will weigh 50 tons each.

The Daido Denrioku K.K. of Japan will install these transformers in a super-power system in the industrial district about Tokio. This super-power zone is similar to that now under consideration for the area between Boston and Washington. One of the Japanese stations, planned for Furukawabashi, will contain 18 transformers with a total output of 169,200 kva.; another at Ohi will have nine transformers with a total output of 82,800 kva.,

and a third at Suhara will be equipped with seven transformers with a total output of 64,400 kva.

Eleven months will be needed to complete the order, which calls for an expenditure of approximately $2,000,000 for the entire equipment.

Mr. Hoover on Electrification

Herbert Hoover, Secretary of Commerce, made special reference to the subject of electrification at the annual meeting of the American Engineering Council of the Federated American Engineering Societies, held at Washington, D. C., on January 5 and 6. Mr. Hoover stated that he thought of electrification as one of the biggest problems confronting the country, and suggested that the engineers tackle this problem in the form of a waste survey. Such a survey, he said, afforded at this time great possibilities in the direction of effective leadership in the elimination of waste. The proposed superpower area along the Atlantic seaboard in the region between Boston and Washington was the starting point, he said, for prodigious development in consolidating the electrical powers of the country along national lines which would affect every village and hamlet, combine into super-power stations thousands of minor electrical plants with millions of horsepower and result in tremendous savings to industry.

Personals

Alfred E. Pratt, sales engineer of the National Carbon Company, Inc., Cleveland, Ohio, has been appointed assistant manager of the railroad department with headquarters at Cleveland. Mr. Pratt was born at West Scarborough, Maine, December 11, 1887, and was educated at Mount Union College and Western Reserve University. After leaving college he spent two years in the maintenance of way department and signal construction on the western lines of the Erie Railroad. In October, 1909, he was appointed supervisor of signals of the Buffalo Creek Railroad at Buffalo, N. Y. In January, 1913, he accepted a position as general signal foreman of construction with the Erie Railroad while automatic signals were being installed on four divisions. In November, 1916, he was appointed signal supervisor of the Buffalo division of the Erie Railroad and in April, 1917, was transferred to the Kent division, with headquarters at Marion, Ohio. On March 1, 1918, he resigned to accept the position as sales engineer in the railroad department of the National Carbon Company.

Alfred E. Pratt

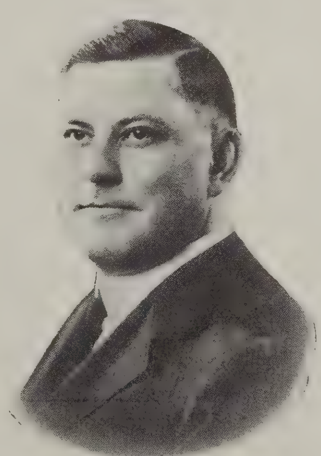
T. T. Atkins, foreman electrician of the Chesapeake & Ohio, with headquarters in the Newport News terminals, resigned his position on November 30, 1921, to become agent for the Velie Auto Company.

J. W. Gibson, formerly leading electrician of the Chesapeake & Ohio, located at Huntington, W. Va., has been appointed foreman electrician of the same road, with headquarters at Newport News, Va., succeeding T. T. Atkins. Mr. Gibson assumed his new duties January 1, 1922.

R. W. Stovel, who served overseas as lieutenant-colonel in the A. E. F. in charge of the mechanical and electrical equipment at all ports used by the American forces, has entered consulting engineering practice with H. A. Brinkerhoff in New York City. Mr. Stovel was graduated from McGill University, Montreal, as an electrical engineer in 1897. From 1898 to 1903 he was with the Pittsburgh & Lake Erie Railroad and from 1903 to 1914 held various positions, including those of mechanical engineer and managing engineer with Westinghouse, Church, Kerr & Company, New York City, and had charge of a large number of railroad electrification and central-station construction undertakings. From 1914 to 1917 Mr. Stovel was with Gibbs & Hill in charge of several railroad electrification projects. After the war he re-entered the employ of Westinghouse, Church, Kerr & Company, later merged with Dwight P. Robinson & Company. Here he remained until he resigned to practice for himself. Mr. Stovel is a member of the A. I. E. E. and an associate member of the A. S. M. E.

R. W. Stovel

Harry Barrett Marshall, who is well-known to many readers of this paper, and who for 13 years was manager of the St. Louis branch of The Electric Storage Battery Co., has been placed in charge of all railway sales work of the company. Mr. Marshall, who will be lolated at Philadelphia, Pa., has been associated with the company for the past 16 years. He graduated from the Armour School of Technology in 1905 and a few months afterwards, joined The Electric Storage Battery Co., occupying a clerical position in the Chiago branch. In 1909, he was appointed manager of the St. Louis branch, which position he has capably filled since that time.



H. B. Marshall

From the very beginning of his association with the company, Mr. Marshall devoted considerable time to the

question of railway sales and as manager of the St. Louis branch, he personally handled all the work in the nature of railway sales himself. That this entailed considerable work can be pictured when it is remembered that Mr. Marshall covered much of the territory that now comes under the jurisdiction of the St. Louis, Kansas City and Denver branches of the company, these branches being established as the business in these districts grew.

Mr. Marshall's wide circle of friends and customers will undoubtedly be glad to hear of the change in his work and know that his efforts in behalf of their own and his company's interests have merited his promotion to manager of the railway sales division.

F. R. Winders has joined the engineering staff of the National Electric Light Association in New York City. Mr. Winders was until recently with the Railroad Commission of Wisconsin.

R. I. Baird has returned to the Electric Storage Battery Company after an absence of four years and is now in charge of western sales of "Exide" batteries, railway car lighting, industrial trucks, etc., with headquarters in the Marquette Building , Chicago. After graduation from the Armour Institute of Technology, Chicago, in 1905, he spent two years with the Automatic Electric Company and worked for some time at Albuquerque, N. M., for this company. Then he served with the Bryant Zinc Company and also with the signal department of the Illinois Central until 1909, when he joined the sales department of the Electric Storage Battery Company, Philadelphia. In 1917 he left this company and went to Montana, where he had charge of the territorial office of the Delco Light Company while developing his own ranch interests.

Cummings C. Chesney, chief engineer and general manager of the Pittsfield Works of the General Electric Company, has been awarded the Edison Medal, "for meritorious service in electrical science or electrical engineering or electrical art" for the year 1921.

This award, which is made by a committee of twenty-four members of the American Institute of Electrical Engineers, and which is among the highest honors of the kind in the field of electrical engineering, was made to Mr. Chesney for his work in the development of transmission apparatus, generators, condensers, transformers and converters during his association with the late William Stanley of the Stanley Electric Manufacturing Company, of Pittsfield, Mass., which concern was amalgamated some years ago with the General Electric Company.

Mr. Chesney is one of the pioneers in electrical discovery. He made plans for the first successfully designed, advanced types of alternating-current generators for high voltages. He was, as stated, associated with the late Mr. Stanley, of Great Barrington, Mass., famed as the inventor of the alternating-current system of long distance transmission.

Mr. Chesney was born at Selingsgrove, Pa., October 28, 1863, and received his bachelor of science degree from Penn State College. After teaching mathematics and chemistry for a time, he became, in 1888, associated with Mr. Stanley. In 1889 and 1890 he was with the U. S. Electric Lighting Company, Newark, N. J., and then became one of the incorporators of the Stanley Electric Manufacturing Company. He was vice-president and chief engineer and manager of that company from 1904 to 1906, becoming chief engineer and manager of the Pittsfield plant of the General Electric Company, with which the Stanley Company was amalgamated in 1906. This position he holds at the present time. He is a fellow of the American Institute of Electrical Engineers and a member of the Society of Arts, London, England.

Charles K. Bowen, assistant engineer of the Pacific Electric Railway, Los Angeles, Cal., has been appointed special engineer of the Southern Pacific of Mexico. Mr. Bowen will have charge of all reconstruction and new construction of Southern Pacific lines in the Southern Republic, on which work, it is understood, several million dollars will be spent almost immediately.

Mr. Bowen graduated from the Agricultural and Mechanical College of Texas as a civil engineer in 1899. Entering the Santa Fe service, he worked his way up until in 1902 he was assistant engineer in charge of construction.

In 1903 he joined the engineering staff of the Pacific Electric Railway as draftsman. From 1906 to 1908 he was chief draftsman. From 1908 to 1913 he was field engineer on location and construction. In 1913 and 1914, as acting chief engineer, he had charge of the construction of the Riverside-Colton-San Bernardino line, Riverside-Corona line, and other extension work, which cost in the aggregate several million dollars.

Several years later he was transferred to the maintenance of way department, in charge of general engineering matters.

In 1918 he was commissioned captain of engineers, U. S. Army, and attended officers' training school at Camp Humphries, Virginia. When the armistice was signed Captain Bowen was commanding officer of Company D., 81st Engineers, at Fort Benjamin Harrison. Mustered out, he resumed his connections with the Pacific Electric Railway, from which he now is going up a notch in the railroad ladder, following his former chief, H. B. Titcomb.

Mr. Bowen will be located at Tucson, Ariz.

Trade Publications

Arc welding for repair and reclamation, general applications of arc welding, and arc welding for manufacturing processes are described and illustrated in leaflet 1825, just published by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. A story is told of how costs are reduced by the use of arc welding.

Oil and Stationary Steam Engines.—Two neatly and attractively arranged educational booklets entitled "Oil Engines" and "Stationary Steam Engines," both of which contain numerous illustrations, the principal features of which are brought out in various colors, have recently been issued by the Vacuum Oil Company, New York. In the first booklet the construction and operation of surface ignition oil engines and other data pertaining to classification, field of service, methods of lubrication, etc., are taken up in a thorough and interesting manner. The second booklet on the subject of stationary steam engines is divided into two parts and treats of the classification of reciprocating steam engines, factors of steam engine operation, mechanical principles, lubrication, etc.; also boiler plant and steam production.

Railway Electrical Engineer

Volume 13 FEBRUARY, 1922 No. 2

You are the Electrical Authority

It is an unfortunate truth, that many men in charge of electrical appliances fail to receive the respect and consideration that is due them. This is particularly so on those roads where the use of electric power is restricted and confined to relatively small installations spread over a large territory. Any tendency on the part of an electrician to belittle his own position because of comparatively limited activities, places the man in a weak position, in which case it is impossible to command the respect of other railroad officers. Even though the use of electrical appliances may not be extensive, the mere fact that they are used at all indicates that someone has considered them of importance and it is strictly up to the man in charge of them to create a feeling of respect for them and for himself. Certain it is that a man who has a small opinion of himself cannot command much respect from others. Be alive to your opportunities. You are the one who is in a position to know the whys and wherefores of electrical equipment. Be sure to know you are right, and the knowledge that you are will surely create a feeling of respect in your associates who will inevitably recognize you as an authority on electrical subjects. Be assertive, but not arrogant. Remember, abnegation never gained influence nor affluence for anyone.

Hoover Talks Frankly About the Railroads

Herbert Hoover, Secretary of Commerce, is noted for his common sense and the frank and convincing way in which he applies it to the discussion of troublesome public questions—national and international. His recent appearance before the Interstate Commerce Commission in the rate hearing must have been a refreshing experience to the commission after some of the testimony to which its members have been forced to listen. One of his replies to a question from Clifford Thorne as to railway financing is typical: "Oh, yes, I have been hearing about that ever since I was a boy, but we have got to live for the future and not rehash the past. I believe the present amount of stocks and bonds is less than the tentative value fixed by the commission. We are faced with a practical question and the commission is dealing with value, not the mass of paper in the markets."

Mr. Hoover believes that lack of foresight and antagonism to the railroads has caused tremendous losses to the public. "There would be no difficulty whatever," he said, "by basing such losses on experiences we have already had, to calculate a loss to the American people of a billion dollars for each one of these periodic transportation shortages." And then again: "We talk glibly of giving billions of credits to foreign countries, to increase our farm exports. I wish to say with all responsibility for the statement that a billion dollars spent upon American railways will give more employment to our people, more advance to our industry, more assistance to our farmers, than twice that sum expended outside the frontiers of the United States—and there will be greater security for the investor." Will the public—will the railway employees and managements help the public—awaken to the import of these words and do its part in assisting to restore railway credit, not so much to help the railways as to help themselves?

Economy in Automatic Operation

There is probably no other form of energy which lends itself to automatic control with the same degree of facility as does electric power. Through the medium of electromagnets, resistances, magnetic saturation, etc., the functions that the electric current can be made to perform are almost without limit. Moreover, the marvelous reliability of such apparatus completely removes any objection to its use on the ground of its not being dependable. It is not at all unusual for automatic equipment to function thousands of times without failure and when failure does eventually occur to find that the lack of reasonable periodic inspection is responsible for the failure.

Automatic electric control is so reliable that it should be used wherever it can be made to show a saving, and there are many places on every road where very real economy may be realized. This is particularly true with regard to pumping for water tanks. Very often the tanks and pumps are situated a considerable distance from other railroad buildings and without automatic operation an attendant would be obliged to spend a portion of his time at least in the simple operation of starting the pump and stopping it again when the tank was full. Such an expense is not justified and is unnecessary. There are instances where the services of two pumpmen have been eliminated and the pumping continued by automatic operation with complete satisfaction and at a very much reduced expense.

A decidedly greater saving has been effected in the conversion of a large air compressor plant from steam to automatic electric operation, making it possible to dispense with the services of three licensed stationary engineers and two firemen. The cost of the electric

power used is about one-half as much as the cost of the coal formerly used and it is conservatively estimated that the saving produced will pay for the new installation in three years.

These examples show unmistakably the economic possibilities for automatic electric control and operation. The reliability of the apparatus is practically unquestionable and if the same, or better, results can be secured at much lower cost, there should be no hesitancy in more generally adopting automatic operation and enjoying the benefits derived therefrom.

Rubber Battery Jars

Rubber jars for lead storage batteries used in car lighting service are now being tried out, or it might be said are again being tried, by a number of railroads. New types of jars made of improved material have been developed by the manufacturers and various claims made regarding their advantages and durability. A few roads have continued to use rubber battery jars practically from the time when electric car lighting was first adopted, but in the great majority of cases the lead tank, for the lead-acid type of battery, has been used. The *Railway Electrical Engineer* intends to publish information on this subject in succeeding issues and is particularly desirous of receiving communications expressing the opinion of those who have had experience with rubber jars for car lighting batteries. Do they meet your requirements and what advantages or disadvantages do they offer as compared with the lead tank used in either open or solid crates?

Business in Railroading

The slogan of the present federal administration is "Less government in business, more business in government." In many cases it is possible to apply a similar rule to railroad practice and put more business in railroading. For example, can you compare the cost of performing some particular operation with the cost of a similar one performed by some industry outside of the railroads? It is not always practical to make such comparisons, but it is often possible.

When stations or other buildings are to be wired at outlying points on one middle western road, local contractors are asked to bid on the job and their estimate is compared with the estimate made by the railroad electrical department. In the majority of cases it has been found that the railroad can beat the contractors' price, but when this is not true, the contractor gets the job. The time factor also enters into such a case and usually in favor of the railroad; if it is necessary that the job be done quickly it may not be possible to wait for a local contractor to make a bid. Where the practice is maintained, however, a healthy condition is created. The railroad gets the advantage of the lower of the two costs and the element of competition keeps all of the electrical workers on the railroad interested in keeping the cost below that of the local contractors. If the railroad workers can do better work at a lower cost, they have the satisfaction of knowing they have done so, and future developments will naturally and automatically be assigned to them

New Books

Life of George Westinghouse. By Henry G. Prout, C. E., A. M., LL. D., 375 pages. Portrait frontispiece and eight other illustrations. Size 6 in. x 9 in. Bound in Cloth. Charles Scribner's Sons, New York.

Railroad men who have thought that the fame of George Westinghouse rested on the air brake alone, will find in this book much to dispel such an illusion. During the 11 years intervening between his 34th and 44th year, Westinghouse took out 134 patents, an average of more than one each month. Not only was he active in the development of his own inventions, but stimulated and directed the work of many other inventors.

Colonel Prout, the biographer, classifies the work of Westinghouse with alternating electric current for the development of power as at least of equal importance with the development of the air brake. In three other fields—natural gas, the turbo-generator and electric pneumatic apparatus for signaling—he did a prodigious amount of work.

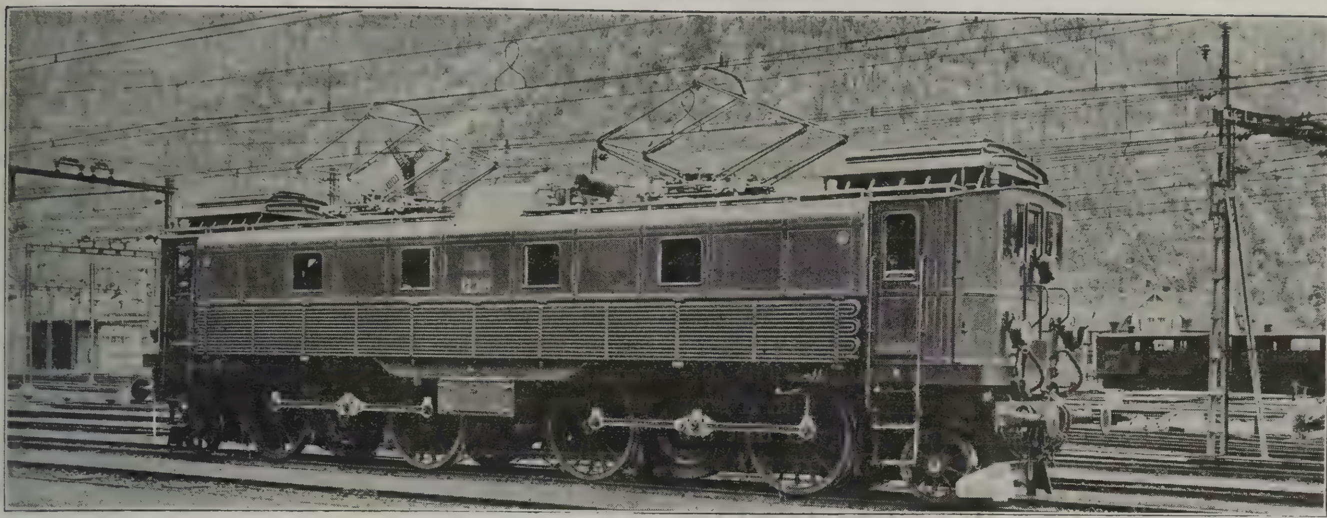
The chapter titles of the book include the following: the air brake; friction draft gear; a general sketch of electric activities; the induction motor and meter; rotary converter; the Chicago World's Fair; Niagara Falls; electric traction; steam and gas engines; the turbo-generator; signaling and interlocking; natural gas; various interests and activities; European enterprises; financial methods, etc. The lighting of the World's Fair at Chicago in 1893 and the epoch-making work at Niagara Falls in 1889, and the following years—where now there are hydro-electric plants with an aggregate capacity of 500,000 h. p.—are among the most absorbing stories in the book.

Electric Arc Welding. By E. Wanamaker and H. R. Pennington. 254 pages, 167 illustrations. Size 5 in. by 9 in. Bound in cloth. Published by Simmons-Boardman Publishing Company, Woolworth Building, New York.

The average user of electric arc welding apparatus will find this book suited to his needs, for it treats the subject thoroughly in language that is easy to understand. The authors hold positions as electrical engineer and supervisor of electrical equipment and welding, respectively, on the Chicago, Rock Island & Pacific. They are men who lead the field in making new and successful applications of the process and have an everyday working knowledge of conditions encountered in actual practice.

The subject matter in the book is confined to autogenous electric arc welding and no attempt has been made to cover electric welding in its broadest sense. The book covers descriptions of welding systems and their installations, phenomena of the metallic and carbon welding arc, training of operators, methods for applying metal to various types of joints and building-up operations, electrode materials used, weldability of various metals, weld composition, thermal disturbances of parts effected by the welding process, physical properties of completed welds, efficiency of welding equipments, welding cost, etc.

This information is that which is most in demand for practical purposes and the book is one of the unusual books that covers a scientific subject without the aid of mathematics. It should be found useful both as an instruction book for teaching the layman the principles of welding and as a reference book for the welding operator.



Locomotive 1B-B1 for Through and Local Service

Monophase Locomotive for Swiss Federal Railway*

A Detailed Description of a Locomotive Designed for Both Freight and Passenger Service

WHEN the Swiss Federal Railways (CFF) decided in the autumn of 1913 to electrify the Gotthard line on the monophase system, they first of all acquired four locomotives for the purpose of making trials. It was not intended to buy new locomotives until these experiments had been carried out. But for various reasons the CFF were obliged in the end to alter their program and buy additional motive power without awaiting the result of these trials. Up till now they have ordered from the Brown, Boveri & Co. electrical equipment of 53 monophase locomotives, of the following types:

41	1B-B1 locomotives	for through and slow trains (one being a trial locomotive).
1	1C-C1 "	for freight trains (trial locomotive).
1	1B1-1B1 "	for through and slow trains.
8	2-C-1 "	for through trains.
2	1C "	for shunting purposes.

The mechanical equipment of these locomotives was supplied by the Societe Suisse pour la Construction de Locomotives et de Machines at Winterthour.

The following description deals in the first place with the 1B-B1 locomotive for through trains and slow trains. The other types of locomotives will be only briefly dealt with.

1B-B1 Locomotives for Through and Local Trains

The 1B-B1 locomotives driven by series of 1 to 14 units only differ from one another by some differences in the diameter of the driving wheels, the ratio of gearing transmissions and the disposition of the brakes. The general arrangement is absolutely the same for all the locomotives. Their power is also identical. The description given below is based on the six last locomotives delivered (Nos. 12313 to 12318). A summary of the terms of the specifications from which the power was fixed appears below.

The 1B-B1 locomotives intended for use on the electrified line from Erstfeld to Bellinzone, must be capable of hauling a through or local train of 300 tons at a speed of 31 miles per hour, or a freight train of the same weight at a speed of 22 miles per hour on a maximum grade of 2.6 per cent. Taking into account a 15 minutes stop at each end of the line, the number of return trips which must be made in 24 hours between Lucerne and Chiasso is three (a total of 844 miles). A train of 300 tons at rest on the 2.6 per cent grade must not take more than 4 minutes to attain a speed of 31 miles per hour.

The equipment must, moreover, be so constructed that an overload of 20 per cent can be allowed on this gradient for 15 minutes, obtained by a proportionate increase of either the speed or the tractive power or both together. The maximum speed of the locomotives is fixed at 46.5 miles per hour.

Mechanical Parts

The lower part of the body which is made of sheet iron, and which extends the whole length of the locomotive is made of strong joists and rests on two bogies joined by an elastic coupling. Each bogie has two driving axles and a carrying axle. The motors, Fig. 1, (two for each bogie) are placed between the two driving axles. There are pinions on both ends of each motor which engage with gears on each end of a jack shaft, also located between each pair of driving axles. There is a flexible connection between the motor shaft and the pinions and the gears are connected to the driving axles by side rods. See Fig. 2. For trial purposes, various types of gearings were used on these locomotives, with straight, helical and herringbone teeth. The details of

*Abstract from a Bulletin of Brown, Boveri & Co.

the experiments are not yet, however, sufficiently complete to decide which of these systems is the best. The openings made in the floor inside the locomotive to allow the play of the motors in relation to the body of the engine, are closed by diaphragms fastened to the motors and sliding on the floor. The two drivers' cabs, Fig. 3, are placed at the ends of the locomotive in order that all the intermediate space may be available for the electrical apparatus. This arrangement has the great advantage of allowing the electrical apparatus to be examined while the engine is in motion. On the very frequent occasions when the engine cannot be taken into a shed or an engine-house, this facilitates inspection. The difference between the weight of a locomotive with a long body and one with large hoods is not so great that the advantage of easy accessibility of the different parts of the electrical apparatus need be sacrificed to it. The roof of the locomotive and the side walls are divided into several parts which are easily removed, so that the electrical machinery and apparatus is easily put in or taken out.

The engine is equipped with the Westinghouse automatic brake.

Electrical Parts

Working on the terms mentioned and on a specification diagram drawn up for the journey to Lucerne-Chiasso and back, the continuous power of the engine was fixed at 2,000 hp. measured on the motor shaft. The

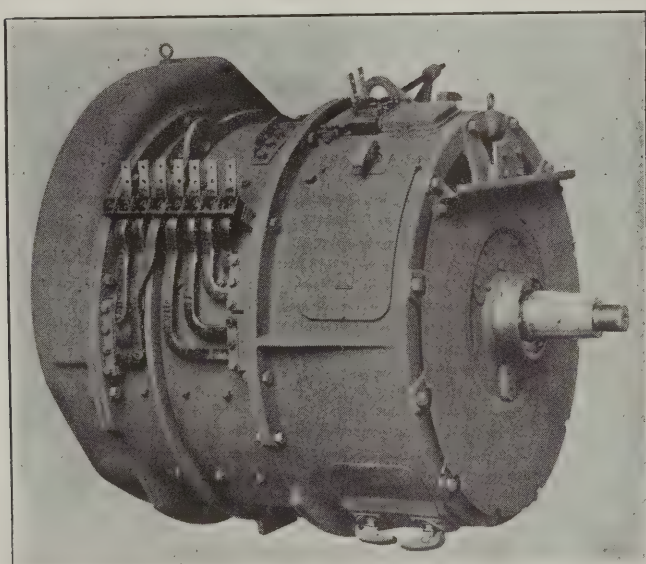


Fig. 1—One of the 12-Pole Motors Used in the Type 1B-B1 Locomotive

following table gives an idea of the capacity of the 1B-B1 locomotive.

Power on the motor shaft, hp.	Speed of the motors, rev. per min.	Voltage per set of motors	Total tractive power at the rim of the wheels, lb.	Speed, miles per hour	Duration of the load
4x500	640	2x525	18,700	36	Continuous
4x600	640	2x550	22,440	36	1 hour
4x750	650	2x580	26,620	37	¼ hour

The maximum tractive power at starting is about 35,-200 lb., corresponding to a motor torque of 4x7,595 ft. lb. The details given above are calculated for driving wheels of 60 in. diameter, a ratio of reduction of the gearing of 1:3.2 and an efficiency of 90 per cent mechanical transmission between the motor shaft and the rim of the wheels.

Before describing the engines and the apparatus, we will say a few words about the electric braking of the locomotive. On lines with long, steep gradients, the wear and tear of the brake shoes and the tires of the engine wheels may be considerable. It is important, therefore, that this should be reduced especially on account of the fact that the particles of metal produced by the wear of these parts easily settle on the electrical apparatus and cause trouble. The arrangement and control of the electric brake must be simple. To meet these requirements a short-circuit single-phase type of brake has been adopted. The working of the brake does not

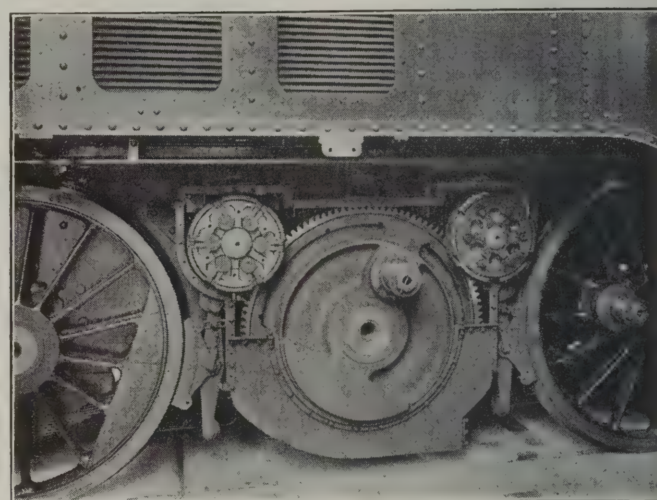


Fig. 2—Showing the Arrangement of the Gear Connections on the Type 1B-B1 Locomotive

require other appliances to be fitted up in the driver's cabs. The distinguishing feature of the apparatus chosen is that the armatures of the driving motors are connected with resistances, while the induction coils are connected with plugs of the principal transformer by means of a small auxiliary transformer and the voltage graduator. The number of notches provided for regulating the speed is 18, the same as for the running. On account of this great latitude of control, the electric brake can be operated and the speed varied practically without any jerk. The use of the whole of these 18 notches is attained by inserting the small braking transformer already described, between the voltage graduator and the coils of the motor field. Owing to this device, the voltage of the current in these coils can be maintained within convenient limits. The diagram of simplified braking, for a set of motors, is shown in Fig. 4. The motors are of the compensated series type with commutating poles and resistances inserted between the winding of the armature and the segments of the commutator. Besides preventing the harmful effect of the static electromotive force, the resistances have the advantage of allowing large sized carbons, which are much stronger, to be used for the commutators. The insertion of resistances also makes it possible to use a high voltage between the segments and the terminals of the motors, causing less current to be absorbed by the motors and consequently reducing their size and weight. The appliances are also fewer and lighter. Moreover, the strains imposed on the commutators and brushes when heavy trains are started

on gradients will be greatly reduced by these resistances.

The 12 handles of the brush holders are fixed to a collar which can be detached by means of an endless screw for the purpose of examining or replacing the brushes.

Although the effort is being made more and more to simplify the electric apparatus on the locomotive by abolishing everything which is not absolutely necessary, the motors have been provided with forced ventilation, for reasons connected with weight and space. A venti-

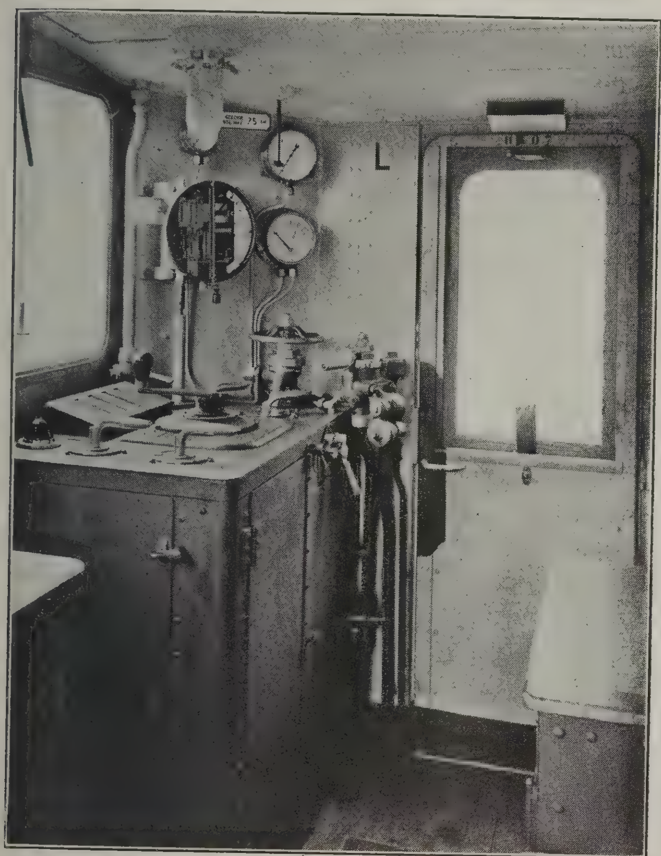


Fig. 3—Interior View of a 1B-B1 Locomotive Cab

lation set is fitted to each motor, made up of a single-phase series motor of 7.5 hp. at 2,000 rev. per min. and a ventilator capable of producing 4,236 cu. ft. of air per minute at a pressure of 3.5 in. of a column of water. The air taken into the engine room on the opposite side from the commutator passes through the motor and emerges by openings made in the end plate near the commutator, taking with it all the particles of carbon produced by the wear of the brushes. We may say, by way of information, that the CFF have calculated that the wear and tear of the carbons is about 0.4 in. for 2,600 miles of road traveled.

The transformer with the oil bath (Fig. 5) installed in the engine is adapted for a continuous power of 1,730 kva. It is fitted up as an auto-transformer with 4 terminals on the primary side, allowing combinations of coils to be made for a voltage at the contact line, of 15,000 or 7,500. On the last engines ordered, the 7,500 volt terminals were omitted for the reason that this voltage which was used on the Gotthard line while the change over from steam to electricity was being made, is no longer necessary. The secondary side of the transformer is furnished with 18 taps, 3 at 825, 1,020 and 1,170 volts also being used for heating the train. The construction of the transformer, differs from the usual arrangement of fixed apparatus even more than that of the motors. The designer's task was very complicated on account of the numerous demands which had to be met in the construction of this apparatus. These demands resulted from the restrictions made with respect to winding and weight, the great mechanical and electric restraints and the large number of terminals. The two horizontal cores supporting the coils are placed in a tank with smooth sides. The coils are firmly wedged on every side so that they cannot get out of shape in case of a short circuit.

A novel device has been adopted for the refrigerating apparatus, which is formed of two systems of pipes erected on the side walls of the locomotive. The total cooling surface is about 750 sq. ft. Owing to this arrangement, it has been possible to dispense with a ventilator, thus saving space in the interior of the vehicle. The oil is circulated by a pump with gear wheels, fitted vertically and driven by a 5 hp. Boveri-Deri motor. Each set of refrigerating tubes can be insulated from the transformer by means of vanes. The results obtained in practice have overcome all the objections of a technical nature which were raised at first against this entirely new system. The fear that this system of cooling would not suffice during the great heats of summer has been proved groundless. At high speeds and in rainy weather, the refrigerator works even better than was anticipated.

High Tension Circuit

The high tension circuit is made up principally of the two pantographs, the choke-coils, the main current breaker and the primary coil of the transformer. The two pantographs, one of which is sufficient to ensure the service in case of necessity, are adapted for a contact wire of a height varying between 15.7 ft. and 21.8 ft. above the rails. The average pressure exerted on the contact line is about 9 lb. The pantograph is operated by compressed air from the two drivers' cabs, or, when air reservoirs are empty by means of a hand pump. Each

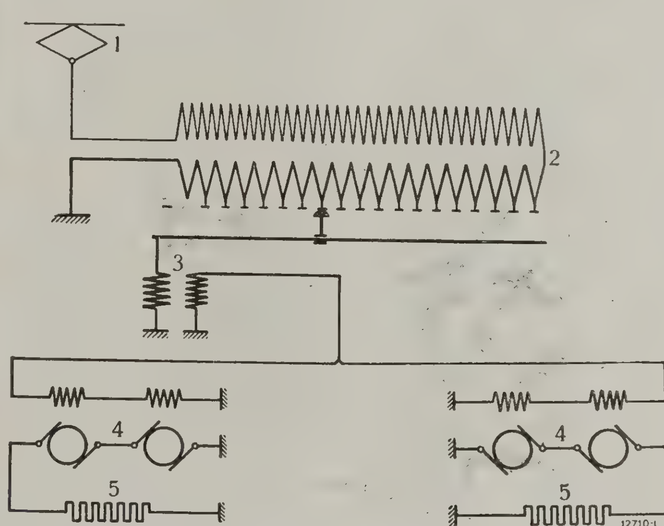


Fig 4—Wiring Diagram for Electric Braking by Short Circuit and Separate Excitation. (1) Pantagraph (2) Power Transformer (3) Braking Transformer (4) Traction Motors (5) Braking Resistances

pantograph can be insulated electrically and pneumatically from the rest of the locomotive apparatus.

The 15,000 volt circuit can be disconnected in the interior of the locomotive by means of a switch fitted in the upper part of the engine room, jutting out on the roof. This apparatus is furnished with a protecting resistance which is as large as the available space allows. The circular shape of the tank makes the apparatus very strong. In the ordinary way, the switch is controlled by electricity, but in case of need it can be worked by hand from the driver's cab. Even in the engine room the switch can be worked by hand by means of a fly-wheel. The machinery is driven by an auxiliary machine. This method was used in preference to control by electromagnet for the reason that it takes much less current and space than is required by the larger controlling conductors with a 36-volt current. The switch also works much more smoothly with this system. This apparatus can also be unlocked by the overload relays of the high-tension circuit, by the no-voltage relays and direct unlocking apparatus connected with the 225-volt terminal of the principal transformer, by the secondary relays of the two circuits of the driving motors and finally by the secondary relays of the switch of the train heating circuit. All these relays are connected to a board with discs showing the driver where the defect is in case of the disengaging of the main switch.

Driving Motor Circuits

One of the chief advantages of the monophase system is the simplicity of the apparatus for starting and regulating the speed while running. This advantage is specially noticeable in the control system with tension graduator used by Brown, Boveri & Co. The tension graduator of large modern locomotives must be adapted for currents of relatively high voltage and intensity, and the apparatus must be constructed accordingly. It will be noticed above all that the commutation spark produced by the passage from one key to another can no longer be left to the brushes themselves, but must be carried by two special contactors attached to the terminals of the graduator and combined with the control.

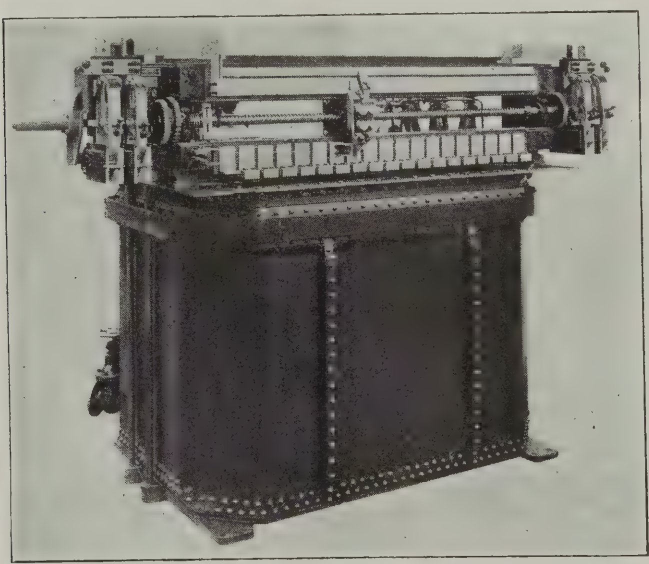


Fig. 5—Oil Immersed Transformer of 1730 Kva. Capacity Installed in Locomotive 1B-B1. Four Taps Are Provided on the Primary Side Allowing Combinations to Be Made for a Voltage of 15,000 or of 7,500. Tension Graduator Mounted on Top

As will be seen from Figs. 5 and 6, the tension graduator includes two systems of bars, each connected to one of the sets of driving motors.

This apparatus is fixed directly over the cover of the transformer in order to reduce the length of the connections going to the latter. It is protected against contact by a railing which also surrounds the apparatus of the 15,000-volt circuit. This railing, which extends from the upper part of the transformer to the roof of the locomotive, cannot be lowered without first unfastening certain bolts, and this in turn cannot be done without first pressing down the pantograph and disconnecting the high-tension circuit by means of the switch for this purpose, which is placed on the roof of the locomotive.

Each set of motors is furnished with a reversing apparatus which makes the connections for running in the desired direction as well as for the braking, and also serves, if required, to insulate one or the other of the sets of motors.

The braking transformer with oil bath and natural cooling is adapted for an intermittent power of 42 kva. at 1260/105 volts.

In order to obtain a high enough degree of cooling, the two groups of braking resistances are fitted on the roof of the locomotive, exposed only to the draught caused by the movement of the train. The cast iron parts collected in frames are placed under shelters which protect them from the weather. Under these shelters are also placed the four motor shunts of undulating ribbons.

Control Circuits and Measuring Apparatus

The strain which is caused by hand-control increases very rapidly with the power and length of the electric locomotives. This is especially the case in controlling motors which the driver is constantly working. Although this class of control is preferred as a rule on account of its simplicity, the advantages of electric control, especially on tractors for shunting purposes and freight trains, were quickly recognized and appreciated.

While there is no difficulty in controlling the main switch by electricity, it is not the same with the tension graduator. It is not, as a rule, possible to regulate the speed of the motors by notches controlled electrically except by a combination of a large number of contactors and relays.

On locomotives 1 B-B 1, the system of control employed reduces the number of relays to a minimum. We will only mention the essential parts without entering into the details. A direct current motor with two field coils and a capacity of 1 hp. operates an auxiliary drive controller called a repeating device, as well as the tension graduator, by means of gear wheels and a friction coupling. The brushes of the repeating device move in the same direction as those of the tension graduator, and, in relation with the drive controllers, placed in the driver's cabs, set up the connections for carrying out the movements desired. Three small relays serve, according to the direction in which the tension graduator moves, to close the motor field coil for forward or backward running, and to close the motor circuit at the same time. A special feature of this system is that it can be used without change with multiple unit control; it is only necessary to connect the control wires to the multipolar

couplings situated at the two ends of the locomotive. Although, for reasons connected with the service, these locomotives were not provided with a multiple control, two of them, belonging to the 12,303-12,312 series were fitted with these couplings and the trials made on the Berne-Thun line gave complete satisfaction.

Dependance upon the trolley line has been eliminated by using a current supplied by a storage battery of the CFF type for driving these control motors. The battery is connected in parallel with a converting set of 1.5 kw. and the voltage employed is that generally used by the CFF for lighting circuits, namely, 36 volts. Variations of voltage from 25 to 45 volts can be allowed for the control (driving-gear).

If necessary, the action of the voltage graduator on apparatus can be made directly by means of a handle.

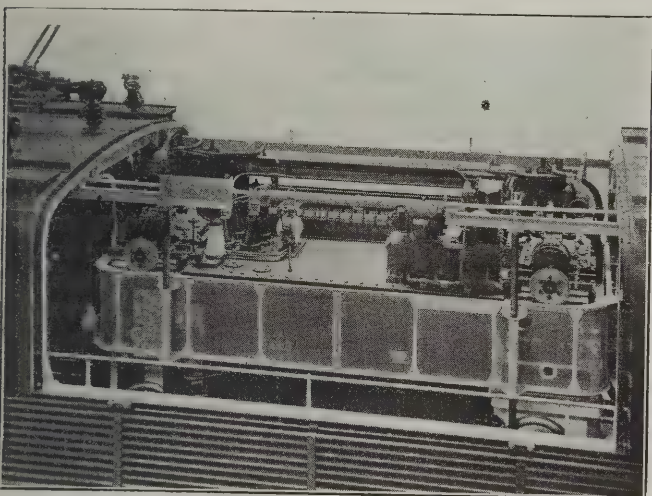


Fig. 6—Central Portion of Locomotive 1B-B1 With Protection Cover Removed

It should also be mentioned that the graduator is furnished with an auxiliary contact connected with a pilot lamp which shows the driver if the graduator is responding properly to all the movements made by the driving-gear controller. Two other contacts attached to the graduator prevent the locking of the main switch and the working of the reversers as long as the graduator is not at the zero position.

Reverse running is also controlled by means of auxiliary motors, but these are much more simply constructed than the tension graduators, seeing that there are only three positions to be attained: "forward," "back" and "brake." In this case also a pilot lamp shows the driver if the reversers are carrying out all the movements prescribed for them and if they are in the same position.

Each of the two driver's cabs are fitted with an ammeter and a voltmeter for high voltage, two ammeters for the two sets of driving motors and a voltmeter and ammeter combined for the heating circuit. In the engine room there is an ammeter and a voltmeter for the dynamo of the converter set and also a watt meter.

Auxiliary Service Circuits

These services include the working of the ventilators, the oil pump and the compressors. They are supplied with a current of 225 volts from the corresponding terminal of the main transformer. While the oil pump switch is fitted inside the locomotive, the ventilator and compressor switches which have to be worked more frequently and which in reality are commutators by means of which the driver can short-circuit the pressure regulators in case of a defect in the working. These latter switches are fitted to the control boards in the driver's cabins. If a fault appears the pressure is regulated by hand by watching the air-gauges. The power and arrangement of the ventilator and oil pump motors have already been given. It is sufficient to add that all the circuits in question can also be connected with the 225-volt system at the engine-houses and car-sheds by means of a two-pole switch and coupling boxes fixed to the frame-beams. In this way the auxiliary services can be controlled with the current plugs depressed.

Heating and Lighting Circuits

According to the specification, the necessary power for heating the trains which must be supplied by the main transformer, is 400 kw., and even 460 kw. for forced heating. The heating circuit can be switched when desired on to one of the auxiliary taps at 825, 1020 or 1170 volts of the transformer. The commutator provided for this purpose not being adapted for operation when carrying current, is connected in series with an oil switch in such a way that a change of coupling can only be made with an open circuit. An overcharge in this circuit unlocks the main switch by means of a relay.

Mechanical Parts	
Length between buffers	53 ft. 7½ in.
Maximum length of the body	49 ft. 4¾ in.
Width of the body	9 ft. 7 in.
Height of the top of the roof above the rails	12 ft. 4¼ in.
Total wheel-base between carrying axles	43 ft. 10½ in.
Fixed wheel-base of the driving axles	10 ft. 8¾ in.
Diameter of driving wheels	4 ft. 11½ in.
Diameter of carrying wheels	3 ft. ¼ in.
Ratio of the transmission of the gearing	1: 3.2
Maximum load allowable per axle:	
(a) For driving axles	20 t.
(b) For carrying axles	15 t.
Number of bogies	2
Distance of the trunnions of the bogies	35 ft. 7 in
Electrical Parts	
One hour hp. rating on motor shaft	4x600 hp. at 640 rev. per min.
Hourly rating of tractive power at the rim of the drivers	About 22,440 lb.
Total continuous power at the rim of the drivers	4x500 hp. at 640 rev. per min.
Total continuous tractive power at the rim of the drivers	About 18,700 lb.
Maximum tractive power at starting	About 35,200 lb.
Continuous power of the transformer	1,730 kva.
Primary voltage	15,000 and 7,500
Secondary voltage	225 to 1,260
Weight Controlled	
Mechanical parts	About 59 tons
Electrical parts	About 49 tons
Total	About 108 tons
Adherent weight	78.2 tons
Average load per axle	19.55 tons

The heating equipment of the locomotive itself is connected to the auxiliary circuit at 225 volts. It includes two radiators of 600 watts and two foot-warmers of 300 watts in each driver's cab, two oil stoves and four sets of heating apparatus for the lubricators of the jack shaft.

The current for the lighting of the locomotive is from a 36-volt circuit. The lighting apparatus consists of six overhead lamps, two lamps in each driver's cabin and six lamps in the engine room. Plugs for portable lamps are provided at various points.

The Compressed Air Apparatus

The compressed air for the pneumatic brake and the pantographs is supplied by two sets of motor-compressors of the BBC type. Each compressor, direct connected to a monophase motor of 9 kw. which drives it, is capable of producing about 42 cu. ft. of air per minute

up to a pressure of 7 at. The maintenance of the pressure in the reservoirs, between very narrow limits (6 to 6.5 at. when interlocking, and 7 to 7.5 at. when unlocking) is obtained by a pressure regulator (one for each locomotive) whose construction has been studied with the greatest care.

In order to complete the above description, the principal features of the 1B-B1 locomotive are resumed in the table on page 49.

Of the 41 1B-B1 locomotives ordered, 17 are already in service, the others will be delivered in 1922.

1C-C1 Locomotive for Freight Trains

The 1C-C1 locomotive, Fig. 7, was ordered at the same time as the trial 1B-B1 locomotive. The terms of the specification for the supply of this locomotive are also based on the traffic conditions on the Gotthard line. The load to be hauled is fixed at 860 tons; on the steeper gradients at 2.1 per cent, a second locomotive is provided to assist by pushing the trains. Between Bellinzone and Chiasso the load is reduced to 625 tons. The speed on the gradients of 2.6 per cent is fixed at 22 miles per hour and the maximum speed at 40 miles per hour.

The mechanical parts of the 1C-C1 locomotive do not differ in the main from those of the 1B-B1 locomotive except in the construction of the bogies, which have three driving axles and one carrying axle, the method of transmission and the presence of hoods at the two ends of the car. Apart from these changes, the same principles are observed in the construction of this locomotive as for the 1B-B1. The two motors of a bogie by means

Fig. 7—Locomotive 1C-C1 for Freight Service

of gear wheels operate jack shaft which transmits the power to the drivers by oblique connecting rods connected to the front driving axle. The simplicity of this method of transmission has largely contributed to giving a certain lightness to this vehicle in proportion to its power and the number of axles. The total weight is about 126.5 tons.

The electrical apparatus only differs from that of the 1B-B1 type in the construction of the motors, which in this case have 14 poles instead of 12. The transformer is the same as for the 1B-B1 type.

This locomotive was put into service during August, 1919. An electric braking device of the regenerative type, BBC system, will shortly be installed. In this method of braking, the field coils of the driving motors are supplied by a phase converter connected with the main transformer, and the induced armature currents feed back into the system by means of the tension graduator which regulates the speed.

The electrical conditions of this method of coupling allows very light arrangement and the power factor obtained is very near unity. The trials made on the Loetschberg line, with a temporary apparatus fitted on this locomotive, gave excellent results.

1B1-1B1 Locomotive for Through and Local Trains

The conditions which the 1B1-1B1 locomotive has to fill are the same as for the 1B-B1 type. The maximum speed, is, however, fixed at 56 miles per hour instead of 46.5.

From the mechanical point of view, this tractor resembles very little the types described above, inasmuch as the transmission by connecting rods is replaced by individual axle control, which is better adapted for attaining a high speed. The individual control devices used are the BBC and Tschanz types. One of the bogies is fitted with individual controls of the first type and the other with devices of the second type. It will, therefore, be possible to experiment with these two systems of transmission on a high-speed, powerful locomotive. In accordance with the high power of this locomotive, the type of motor used has 14 poles. With this exception, the arrangement of the electrical parts does not differ much from that of the 1B-B1 tractors.

2-C-1 Locomotives for Through Trains

These tractors are more particularly intended for running on lines on the plains with a maximum gradient of about 1 per cent. The power was fixed according to the tractive power and speed curves calculated with the CFF dynamometric car for a train of 480 tons on the Villeneuve to Brigue and Zurich to St. Gall lines. The locomotives are equipped with three motors of a total hourly capacity rating of 2100 hp., each operating an axle by means of an individual control device, the BBC system. These tractors differ greatly from those of other types from the electrical and mechanical point of view. A detailed description of them will be given later.

The first 2-C-1 locomotive is already running, and the others will be delivered very shortly.

1C Locomotives for Shunting

Although it appears likely that the steam locomotive will still hold its place for a long time for this work, two electric shunting locomotives were ordered during May, 1921. The conditions of the shunting service are entirely different from those of other kinds of traction, and as there have been but few opportunities up till now to make experiments, these two locomotives must be regarded as trial tractors. The control system of other locomotives will depend on the results obtained in practice.

The power of these tractors was also based on the calculations made with the CFF dynamometric car. The electrical equipment will include a driving motor with an hourly capacity rating of 690 hp. of the same type as that on the 2-C-1 locomotive, a small oil cooled transformer with a continuous power rating of about 500 kva. and a controlling device with 13 notches. The driver's cab is placed in the centre of the locomotive, giving good visibility in all directions.

Standards of Railroad Shop Welding Practice

Workable General Rules Are Given; Also Typical Examples of Proved Boiler Welding Practice

By G. M. Calmbach
Welding Engineer

IN order that greater uniformity and better results may be obtained in preparing work and making welds, the following methods and practices have been selected after considerable study, experiments, and personal observation of the welding work in many shops throughout the country. They are considered the best and most practical

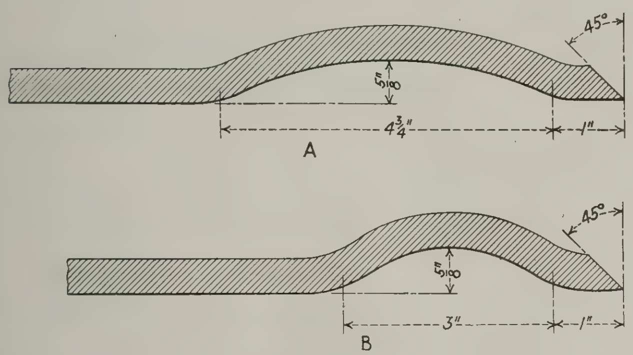


Fig. 1—Standard Corrugations for Boiler Sheets and Patches

methods in use today and are recommended as a standard practices, to be followed as closely as local conditions will permit. Each foreman and welder who follows these instructions will find his work more reliable and satisfactory.

1.—In welding cast iron, brass, cast steel, and forgings, all such work should be fire-heated whenever possible to

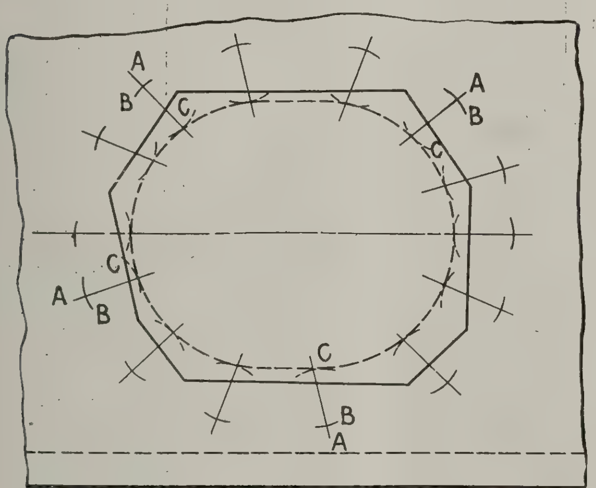


Fig. 2—Method of Laying Out Patches for Welding

insure a better weld, as well as to save gases. That is to say, all parts that take considerable time to heat with the torch sufficient to commence welding should be preheated so that when the welding flame is applied the part to be welded will respond almost immediately. As the oxy-acetylene torch cost per hour is extremely high it is easy to see that the heating of ordinary heavy parts with the oxy-acetylene flame is a very expensive operation and should be eliminated as much as practicable.

All foremen in charge of such work should use good judgment and take personal interest in this matter and see that the proper provisions are made and work carried out accordingly. The preheating of cast iron, brass and other heavy castings is not only necessary for the saving of gases and time, but is also necessary in many cases to take proper care of expansion and contraction.

2.—In making a successful weld there are five very essential and important things to consider: namely, (1) Condition of surfaces; (2) bevel of sheets; (3) position of sheets; (4) provision for expansion and contraction, and (5) proper filler metal.

The importance of these points cannot be over-estimated and the failure to comply with the instructions covering any one of them will result in a questionable

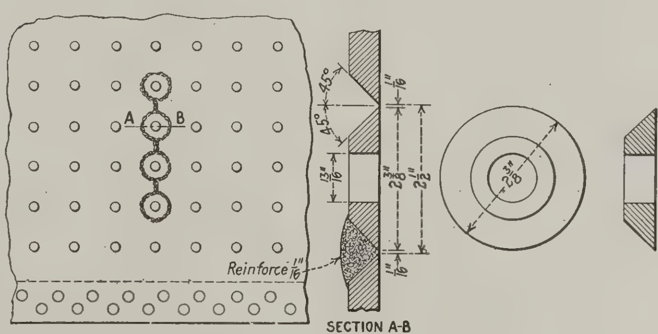


Fig. 3—Method of Welding Cracks Through Staybolt Rows; Gas

or bad weld. The success of a weld depends on the rigid observation of these items.

3.—When sheets and patches are to be applied extreme care should be taken that all defective parts are cut out and also that they are cut so there will be a good foundation for the weld.

4.—All sheets and patches should be cut out on a straight or uniform line, avoiding staybolts wherever possible so that staybolt threads may be cut in unwelded plate.

5.—Never cut out sheets or patches through the old weld where sheets have been welded previously. For side sheet or three-quarter door sheets, extend the new sheets at least one staybolt row higher; for crown sheet, one staybolt row lower; for patches, at least one row of staybolts larger; for flue sheet, extend weld to one row of staybolts lower.

6.—Do not cut out sheets or patches and bevel the sheets at the same time. If the sheets are to be beveled with the torch before chipping it can be done after the parts are cut out; this is necessary to insure a uniform line, as well as a more perfect fit of the new parts.

7.—Clean surfaces are absolutely necessary for making good welds. If scale, rust, or grease is permitted to remain on the surface to be welded a slag is formed that

will make a streaked and seamy weld. All surfaces must be kept free from foreign substances; all welding surfaces must be kept clean and bright.

8.—Experience has proven that the most satisfactory angle of the beveled faces preparatory to making the weld is an angle of 45 deg. with the surface of the sheets. The total angle between bevel faces must be 90 deg. in all cases, even if one sheet has to be beveled more than the other. Improperly beveled sheets prevent the welding flame from properly penetrating the bottom of the weld and prevent the weld from uniformly uniting with the edge of the sheet.

9.—Where horizontal welds are to be made with the

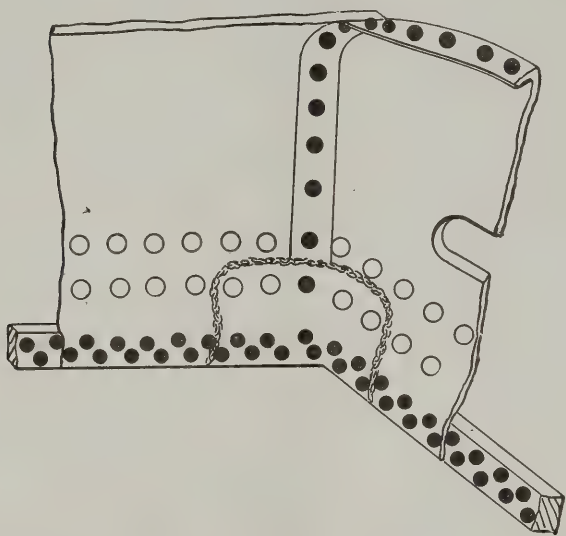


Fig. 4—Application of Mud Ring Corner Patches; Gas or Electric

electric welder it has been found a very good policy to bevel the bottom edge to about a 60-deg. angle and the top edge to about 30 deg.

10.—All sheets and patches are to be fitted carefully with an opening of 1/8 in., no more and no less, between

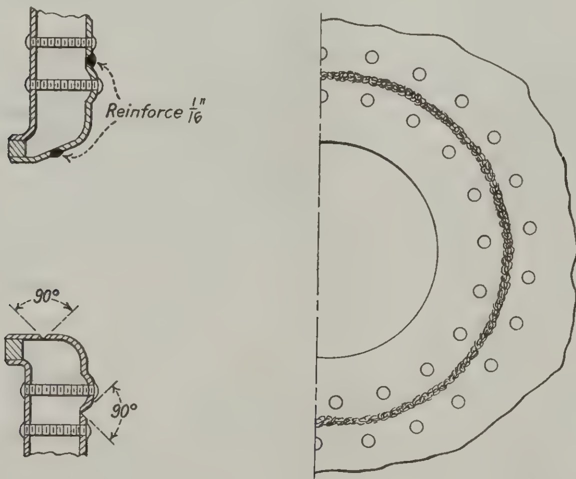


Fig. 5—Butt Welded Fire Door Patch; Gas or Electric

bevel edges. Less than 1/8 in. opening between the sheets will not permit the welding flame to penetrate the weld properly and a greater opening requires too much filler metal to be used, not only increasing the cost of the weld, but making it impossible to keep the surface of the weld opposite the torch smooth. This rough surface permits lamination and seams on the water side of the sheet, weakening the weld and permitting early corrosion of the metal which tends to part the sheets.

11.—All other precautions may be carefully made and yet a faulty weld will be made if due care is not taken to allow for expansion and contraction of the sheets. Where it is not possible to obtain the necessary expansion and

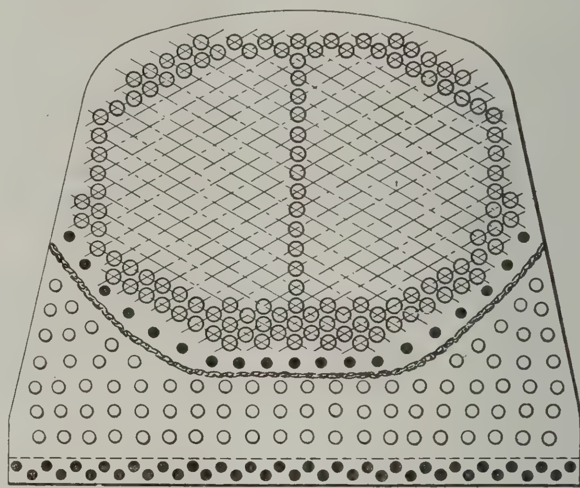


Fig. 6—Method of Applying New Tube Sheet Section; Gas or Electric

contraction through curves of the adjacent sheets, it is then necessary to provide some method to take care of expansion and contraction. In this case all sheets and patches will be corrugated, as shown in Fig. 1. A strain on a weld, especially where the new sheet is welded to an

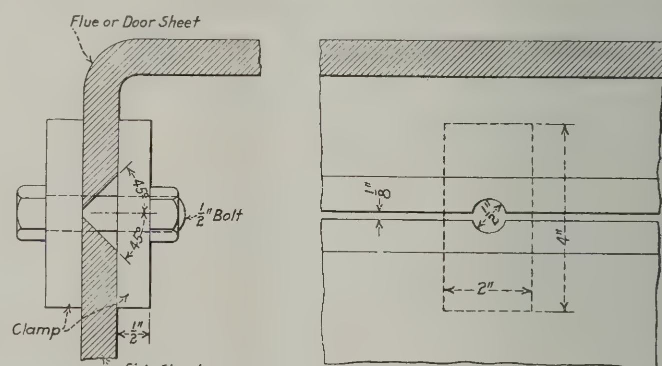


Fig. 7—Clamp for Holding Fire Box Sheets in Line When Welding

old sheet, which is generally the case, is particularly harmful as the old sheet will not stretch as much or as uniformly as the new one.

12.—When fitting corrugated sheets or patches, they should be bolted securely in place and when they extend to the mud ring good drift pins should be inserted in the mud ring holes so that the sheet cannot move upward due to the contraction as the contraction should be taken from the corrugation. Bolt the sheets at the welding end as usual. That is to say, insert a 5/8-in. bolt through every fifth staybolt hole and screw in a staybolt from the outside between each of the 5/8-in. bolts, thus holding the sheets in line. Then insert small wedges between the welding edge spaced about 14 in. apart to keep the sheet from pinching together during the welding.

13.—Where side sheets are to be welded at the ends it is necessary to remove the adjacent row of staybolts to

the edge of flange of door or flue sheet before welding is commenced. It is also advisable to remove all staybolts adjacent to welds after the welding is completed.

14.—When welding corrugated sheets or patches with the oxy-acetylene method the following instructions are to be carried out; with every 12 in. of welding completed,

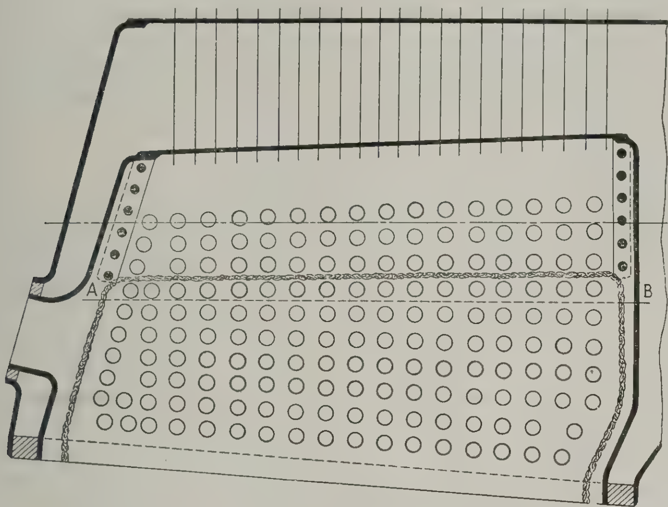


Fig. 8—Side Sheet Application; Gas or Electric

the operator will stop and heat a line 1 in. wide through center of corrugation to a red heat and continue this until the weld is finished.

15.—No fire box welds should be reinforced more than 1/16 in. as too great a reinforcement is injurious to a weld due to over-heating when in service.

16.—For firedoor patches when collars are to be welded they should be cut out at a point where at least one row of staybolts is in the patch and as nearly round as possible.

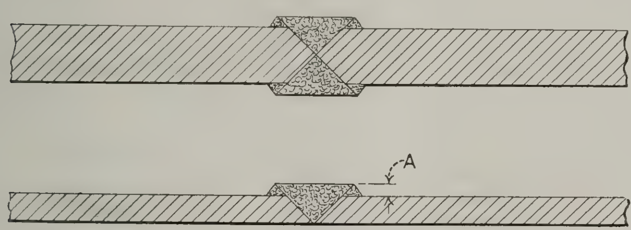


Fig. 9—Cross Sections of Standard Welds Showing Single and Double Reinforcement

When the patch is cut out at a point 6 in. or more from the firedoor edge it should be corrugated all around as shown in Fig. 5. It will not be necessary to corrugate if the patch is cut out less than 6 in. from the door hole. When firedoor patches are extended to the mud ring and 6 in. or more from the firedoor edge the patch will be corrugated all around but where patches do not extend to 6 in. from the firedoor edge, it will only be necessary to corrugate both sides of the patch from a point about half way from the firedoor down to the mud ring.

17.—The welding of cracks in side sheets, door sheets, firedoors, crown sheets, bottom and top of flue sheets should never be attempted as such attempts have been a source of much trouble and many engine failures. However, it may be considered necessary at times to weld certain cracks. This practice should be resorted to only in occasional emergency cases and then such work should be classed as strictly temporary and be corrected at the first opportunity. It is, of course, known that such work as welding cracks in the barrel of a boiler, welding over staybolts and welding staybolts is strictly against the law and will not be allowed at any time.

18.—When it becomes necessary to weld seams that have given away, such as those between door or flue sheets and side sheets, the rivets should be removed and the outside of the fire side lap should be cut off through the center line of rivet holes. Do not cut the side sheet and see that it is cleaned thoroughly before welding is commenced. Weld the holes solid and lap weld sheets.

Fitting, Preparing and Welding Fireboxes

19.—For fitting, preparing and welding a firebox without removing the back end the firebox should be set up on

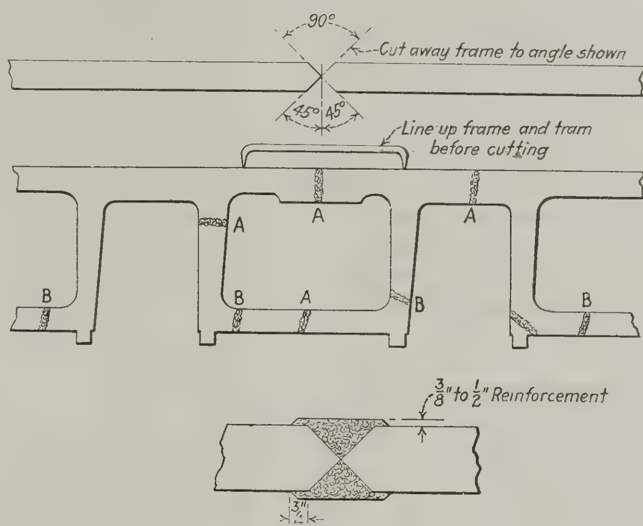


Fig. 10—Location of Common Frame Breaks and Method of Welding with Gas

the floor with all staybolts and mud ring rivet holes drilled, except mud ring corner holes, which should be drilled after the sheet is up and welded.

The welding edge should be chipped to a 45-deg. angle

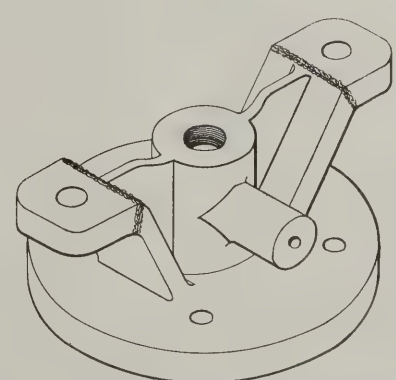


Fig. 11—Air Signal Valve Casting Repaired by Gas Welding

and chipped on a straight line so as to insure a uniform opening of 1/8 in. between the welding edges.

The lower portion of the sheet from a point about 14 in. from the bottom of the flue and door sheets should not be chipped until the box is in place and the mud ring corners in place.

Bolt the sheet securely in place, being sure that there

is a uniform opening of 1/8 in. all around the welding edge.

Use a 1/2-in. drill and drill holes spaced about 14 in. apart, using 1/2-in. machine bolts with clamps made of boiler plate 1/2 in. by 2 in. by 4 in. Use one of these pieces on each sides of the sheet, being sure that all bolts are drawn tight.

Rivet the top of the flue sheet to a point not less than 12 in. below the center of the crown; start welding at a point about 10 in. below the rivet and weld up to the rivets. Then drop down 10 in. and weld up to the end of the previous weld. Continue this operation until completed, removing clamps when necessary. Weld the entire door sheet.

Examples of Boiler Shop Welding

The method of making corrugations for side and door sheets to allow for expansion is shown at *A*, Fig. 1. The corrugation for patches is more pronounced and is shown at *B* in the illustration.

In laying out patches previous to welding it is sometimes difficult to cut them accurately unless some such method as the following is used: After the sheet has been cut out and beveled, the lines *A*, Fig. 2, are scribed as shown. With the dividers set at about 6 in. arcs *B* are scribed from the edge of the bevel. When the patch is ready to lay off for size, it is bolted firmly into place, as shown in Fig. 2. The lines *A* are then scribed back on the patch a short distance. With the dividers set at the same distance used before and with the intersections of lines *A* and *B* as centers, arcs *C* are scribed on the patch. Where these arcs intersect lines *A* are points on the edge of the patch. A smooth curve is drawn through these points and the patch cut to the line. It can be then beveled and welded in place in accordance with the standard practice at local shops.

Boiler plates cracked through staybolt poles are a common occurrence and often give much difficulty before repairs can be made. One method of overcoming this difficulty is illustrated in Fig. 3 in which a new circular section of boiler plate drilled and beveled as shown at the right is applied by welding. It will be noted that the bevels are cut at an angle of 45 deg. and the weld is reinforced by adding 1/16 in. to the thickness of the original plate.

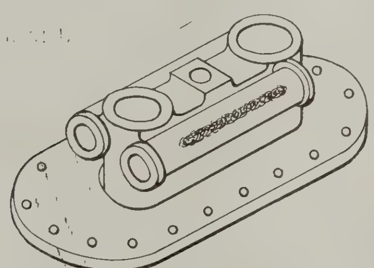


Fig. 12—Air Compressor Steam Head Reclaimed by Gas Welding

An interesting example of the method of applying mud ring and corner patches is shown in Fig. 4. This operation can be performed either by gas or electric welding, but the caution should be observed of never laying out the patch so that the weld will come lower than between the first and second rows of staybolts above the mud ring.

The method of applying a butt-welded firedoor patch is shown in Fig. 5. The corrugation to allow for expansion is shown and, as in the previous instance, the patch is beveled to an angle of 45 deg., the weld being built up an additional 1/16 in. for reinforcement.

When constant reworking of tubes and flues has damaged the flue sheet bridges, but the lower portion of the sheet is in good condition, the method of repair by welding in a new top section is shown in Fig. 6. This method effects quite a saving in time since the top flue sheet section can be more quickly laid out and formed, and the labor of cutting and reapplying staybolts in the lower section is eliminated. If any difficulty is experienced in bringing the edges of the new and old plate in alinement previous to welding, a special clamp, as shown in Fig. 7, can be used.

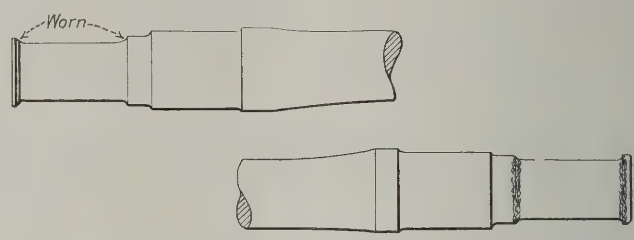


Fig. 13—Building Up Worn Axle Collars; Electric Welding

One of the most successful uses of welding in boiler work has been in the application of side sheets and half side sheets. The application of a full side sheet is shown in Fig. 8 with the corrugation for expansion along line *A-B*.

In making heavy frame welds with gas it is essential that the parts be carefully cleaned and prepared for welding by cutting the ends to the proper angle and making necessary allowance for contraction in cooling. It is also wise, wherever space permits, to build up the weld a certain proportion larger than the original cross section in order to provide additional strength.

The standard method of cutting, welding and reinforcing bolsters, truck side and engine frames, and all other steel, iron, or cast steel from 3/4 in. to 8 in. in thickness is shown in Fig. 9 and the accompanying tables.

STANDARD REINFORCEMENT FOR ALL HEAVY WELDING

Thickness of Material	Proportional Increase in Thickness
3/4 in. — 1 1/2 in.	A = 25 per cent
1 1/2 in. — 2 1/2 in.	A = 15 per cent
2 1/2 in. — 4 in.	A = 10 per cent
4 in. — 6 in.	A = 7 per cent
6 in. — 8 in.	A = 5 per cent

STANDARD V FOR HEAVY WELDING

Thickness of Material	Angle of V
3/4 in. — 1 1/2 in.	One side — 45 deg.
1 in. — 2 in.	One side — 55 deg.
1 in. — 2 in.	Both sides — 45 deg.
2 in. — 3 in.	One side — 50 deg.
2 in. — 3 in.	Both sides — 55 deg.
3 in. — 4 in.	Both sides — 55 deg.
4 in. — 5 in.	Both sides — 55 deg.
5 in. — 6 in.	Both sides — 55 deg.
6 in. — 8 in.	Both sides — 55 deg.

The amount of reinforcement provided is a certain proportion of the cross section decreasing in amount as the size of the section increases. It will also be noted from the tables that the angle to which the broken parts are cut or V'd varies from 45 deg. to 55 deg., all sections over two inches thick being V'd and welded from both sides.

Preparation for Frame Welding

As in the usual practice the frame to be welded is lined up, trammed and checked with the opposite side as shown

in Fig. 10. The weight of the engine is taken off the frame and jacks placed under the jaws on either side of the weld. Then tram over the break, locating permanent points by which the expansion will be governed. Referring to Fig. 10, the frame should be cut out from both sides to the angle shown, all surfaces being chipped and cleaned preparatory to welding. It is necessary to spread the frame a suitable amount to allow for contraction in cooling, this allowance for contraction varying slightly in amount depending upon the location of

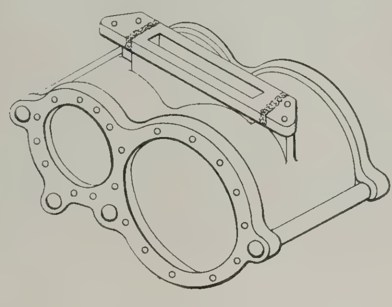


Fig. 14—Air Cylinder Lugs Replaced by Gas Welding

the break. Referring to Fig. 10, when breaks occur at points marked *A*, ¼ in. should be allowed for contraction. At points *B* 3/16 in. is allowed. Whenever welds are to be made in any part of the jaw the binder should be in place if possible. A ⅜ in. plate should be tacked to the lower side of the frame on which a foundation can be made to start the weld. This plate extends out on both sides of the frame the thickness of the reinforcement and is welded firmly to the frame at all points of contact

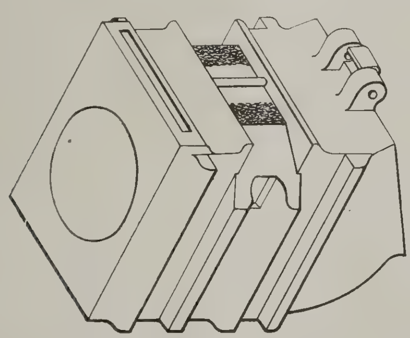


Fig. 15—Building Up Worn Journal Box; Gas Welding Used

including the edges. This plate forms a base on which to start the weld.

Two operators should be employed, one on each side of the frame. After the weld reaches the thickness of two inches it should be hammered, this hammering to continue at intervals until the weld is finished. It is important that at no time during the process of the weld any part should be less than red hot. That is to say, the operator should keep the finished part of the weld red hot at all times and when the weld is finished the entire weld should be brought up to an even heat before jacks are removed. This will relieve any internal stress and will, at the same time, decrease the possibility of future breaks.

For the amount of reinforcement to be applied reference should be made to Fig. 9 and the accompanying tables.

Miscellaneous Welding and Building Up Jobs

The possible uses of both gas and electric welding in railroad shops are too numerous to mention and both processes have been greatly extended during the past few years, saving large sums of money annually to the railroads. The important point to be remembered, however, is that either welding process costs money and if the locomotive or car part being repaired or reclaimed is small and has a first cost less than the cost of gas or electricity and labor used, it is obviously poor economy to weld it.

For the air signal valve casting, as shown in Fig. 11, however, the cost of labor and gas used in welding on the broken lugs would be considerably less than the cost of a new casting, and it is therefore good economy to make

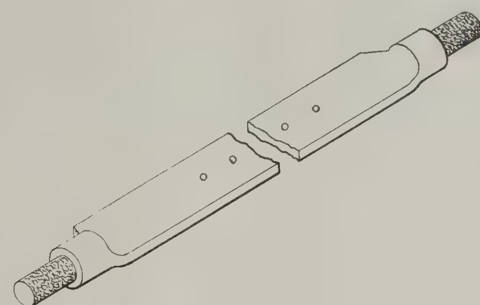


Fig. 16—Building Up Brake Shaft Ends; Electric Welding Preferred

the repair by welding. The castings after being welded by competent operators will be just as good as new.

An interesting example of what can be accomplished with gas welding is shown in Fig. 12. The steam head of the New York air compressor is located at the bottom and, without proper care in draining during the cold weather, will often become cracked through the wall to the exhaust passage as shown in Fig. 12. This steam

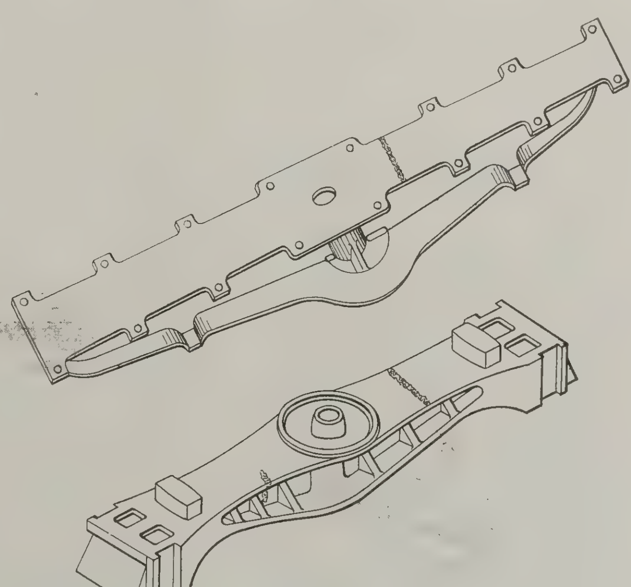


Fig. 17—Steel Car Bolster Effectively Repaired by Gas Welding

head is quite an expensive casting with a more or less intricate system of coring in which it was found necessary to maintain walls of equal thickness. The problem in getting a successful weld on this casting is to provide for contraction and this can be accomplished only by the

careful and thorough pre-heating of the steam head after which the crack can be welded with gas. The entire weld and adjoining walls of the casting should be brought to a uniform temperature and allowed to cool slowly to prevent internal strain and a subsequent crack which will be worse than the first.

Building Up Worn Parts

Among the possible uses of welding processes perhaps none is more important than the building up of worn parts, in many cases making them as good as new for further use. The example shown in Fig. 13 is a worn axle collar before and after being built up by electric welding. After the welding has been completed it is necessary to mount the axle in a lathe and remove excess metal deposited on the collar, leaving a smooth fillet of the original dimensions.

Another example of welding broken lugs is given in Fig. 14 in which both lugs have been broken from an air compressor cylinder, either through a wreck or accidental dropping or mishandling on the floor. The common method of repairing a cylinder with broken lugs is to have new lugs forged of wrought iron or axle steel in the forge shop, fitted to the cylinder which has been properly machined, and secured in place by three or more bolts through the extended sides of the lug and the cylinder. It is obvious that in both cost and length of time required to make a repair, welding is much to be preferred over the mechanical process of applying new lugs.

The method of building up a worn journal box and the ends of an engine brake beam are illustrated in Figs. 15 and 16, respectively. Both of these parts can be built up and made as good as new in a very short time and at a slight cost. In the case of the journal box it is advisable to use gas for building up but with the brake beam the electric method would be better. In case gas is used to build up the worn brake beam ends, great care must be exercised not to over-heat the ends and the entire beam should be carefully annealed before being machined and put back into service. Otherwise there is a good chance of a train delay on account of dropping the brake beam.

The possibilities of welding are also illustrated in Fig. 17 showing heavy steel car bolsters which have become cracked at two points in service and would have to be scrapped were it not for the possible use of the gas welding process in repairing the cracks. As in the case of all complicated castings subjected to tension it is impossible

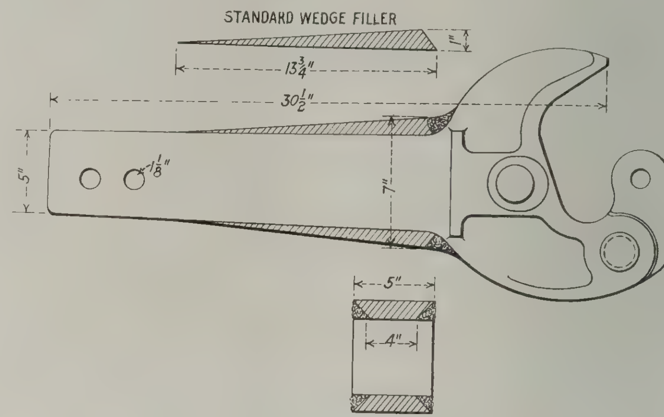


Fig. 18—The Addition of Wedge Fillers Changes 5 In. by 5 In. Coupler Shank to 5 In. by 7 In.; Gas or Electric

to weld one section and have it cool off without causing internal stress. For this reason due allowance must be made for contraction in cooling and the careful annealing of all parts after welding is necessary to insure a permanent weld.

Another interesting example of welding is shown in Fig. 18 in which a 5 in. by 5 in. coupler shank is changed to a 5 by 7 by the addition of a standard wedge filler held in place by either electric or gas welding as shown in the illustration. One end and both sides of the filler are undercut as shown in the cross sectional view, the undercut space being filled in with welding material, thus holding the wedge filler firmly to the coupler shank. The preceding are but a few of the many interesting examples of welding work performed in modern railroad shops.

Photo by Keystone A Train on the Chinese Eastern—the Eastern End of the Trans-Siberian

An 11,000 Volt Single Phase System

Electric Traction for Steam Railroads

Tendencies of Practice in the United States. Limitations and Advantages of Equipment Used

A REPORT on heavy electric traction which deals particularly with results obtained in the United States and Canada has been prepared for the ninth International Congress of the International Railway Association by George Gibbs, chief engineer of traction, Long Island. The report deals with the subject from the standpoint of a railway man who has been in contact with the technical details, but who is writing for those not specially versed in them. Mr. Gibbs has dealt with the subject in an unusually thorough fashion and has made a number of pertinent statements well worth the attention of anyone interested in heavy electric traction. The outstanding parts of the report are set forth in the following:

In 1910 electric traction was in service in the United States and Canada on 11 different railroads including a total of 873 miles of track. At the end of the year 1920 the number of roads had increased to 19 and the miles of track to 3,370.

This indicates considerable growth in the use of electric traction during a ten year period, but the greater part is due to projects determined upon prior to the war. It may be said that for the past six years electric traction has been in the condition of arrested development—a situation which unfortunately, applies in some measure to its technical aspect as well as to its physical.

Advantages Secured

The reasons for which electric operation has been adopted have been so often stated that it is unnecessary to enlarge upon them at length, but it will be useful to note that the trend of development of electric traction in America has primarily been to secure better operating conditions, thus:

(1) For terminals, in large cities where tunnel approaches are generally involved (or in long tunnels elsewhere) and usually where steam locomotives are objectionable. Also, because switching and idle power movements can be reduced by using motor-car trains instead of locomotives for haulage. These advantages may greatly increase the capacity of a terminal or a tunnel.

(2) On heavy gradients (sometimes in connection with hazardous steam operated tunnels) where the running speeds with steam traction are low; to increase the capacity of the line and effect substantial operating savings.

(3) For short-haul (suburban) passenger services, to increase track capacity because of quicker schedules in services having many stops, and incidentally, to foster business, due to the attractiveness of electric operation from the standpoint of the traveler.

(4) In certain cases for long-haul services; for the main purpose of securing operating economy in districts where coal is expensive and where cheap hydro-electric power can be obtained.

In other words, the great majority of the installations have been undertaken to facilitate operation over some particularly difficult or congested portion of a railway. In all cases the direct operating savings plus the indirect advantages are sufficient to justify the adoption of electric haulage.

Locomotives

No approximation, even, to a standard electric locomotive design has been arrived at. The problems still ahead for solution are both electrical and mechanical; the former await the selection of a system and the development and perfection of apparatus, the latter relate

to the working out of methods of transmitting power from the motors to the driving wheels and securing the best type of locomotive structure for perfect tracking properties. It may be said, however, that the serious problems awaiting solution at present are mechanical, rather than electrical; motors and control of both the d. c. and the a. c. types work well; of the mechanical features we know little of a conclusive nature—experience has been too limited with electric locomotives.

Locomotives with motors direct-geared to axles are suitable only for slow-speed locomotives, such as those for switching or freight services. For the heaviest requirements of freight haulage, however, it is doubtful if this type is the best, because it is difficult to apply the drive to produce a stable wheel-grouping; also because the heavy motor masses have a very low center of gravity and the un-spring-borne weights are very considerable. Large motors, furthermore, produce severe side shocks in curving and with track in poor surface and hub-liner wear is apt to be great.

Locomotives equipped with quill driven geared motors, should produce better results in the above respects, but only in degree. A quill drive has not been entirely satisfactory for very heavy service, because mechanically it is difficult to find space for conservatively designed springs, and if the quill is not maintained normally concentric with the axle severe bending stresses are set up in the springs at each revolution of the wheels, whereas a helical spring should be subjected to torsional stresses only. Therefore, quill drive appears to have a distinct limitation in successful application to electric locomotives.

The type of locomotive which has the motor armature mounted rigidly on the axle, requires many axles for heavy traction, and a locomotive wheel arrangement which is somewhat complicated and unfavorable for tracking. It has been used for high speed work, however, in cases where track construction is of the heaviest character and its maintenance is of the highest order; its field is limited to high speed service because of low output of the motors at low speeds.

Gearless motors flexibly suspended around the axles, may be used for high speed passenger locomotives with either d. c. or a. c. traction, but it is not an economical type as regards first cost of motors and it has a low center of gravity of the running gear. It is furthermore subject to the difficulty mentioned above in securing durable spring-driving mechanism.

Locomotives having gearless motors and rod drive are suitable for high-speed passenger work with both d. c. and a. c. motors, and this type of drive allows the most desirable wheel arrangement and weight distribution for perfect tracking qualities of the locomotive. The motors, however, are very large and costly because of their necessarily low armature speed and correspondingly limited capacity; the type is not suitable for low-speed service.

The type of locomotive having geared motors and a rod drive, offers the most flexible and promising solution for passenger and freight locomotive construction, because of the allowable variation in wheel arrangement and in motor mounting and capacity; it permits most perfect tracking qualities for a great variety of designs and running speeds. It is suitable both for d. c. and a. c. traction systems.

Side rods connecting the various driving wheels are desirable in all types to prevent slipping of independent axles and to thus obtain maximum traction, especially with d. c. motors having series-multiple control.

A combination of driving and carrying axles is desirable, also an unsymmetrical wheel distribution, to assist in proper tracking. This point was clearly brought out by the experiments made by the Pennsylvania Railroad Co. in 1909 when they took up the design of their electric locomotives for use in the New York Terminals. *Railway Electrical Engineer,* December, 1921, page 447.

Motor Cars

American practice tends to a motor car which will have the largest passenger capacity consistent with the economical limits to the application of sufficient motive power to the car. Best economy in equipment and maintenance cost is obtained by using two motors only and mounting them on one truck. A modern car of steel construction and of about 70 feet length overall will satisfy these conditions. It will weigh, without electric equipment but including full seated passenger load, about 50 tons (100,000 lb.). Two motors will give a capacity of about 500 hp. total for the car, and with this capacity the most exacting local service schedules can be performed, provided all the cars in the train are equipped with motors.

Existing electrifications for such service are now conducted by the 650 volt d. c. system, and by the high tension single-phase a. c. system, and by the 1,500 volt d. c. system with two motors per car; the high tension (3,000 volts) direct current system, requires four motors per car, because of the necessity of limiting the voltage in each motor to 1,500, and to obtain series-parallel control of the motors. Motor-car equipments for the 3,000 volt system have not yet been under practical trial on any electrified steam railway in America.

Current Collection

Third rail conductors have sufficient current-carrying capacity for all traction conditions even with low voltages, but it is believed that the third rail working conductor systems have become obsolete for general railway electrification in America.

The overhead working conductor systems will become standard in the future for general electrification, and the two important electric systems, namely, the alternating current and the high tension direct current must be adapted for all requirements with this form of conductor.

At the present state of the art, the 11,000 volt alternating current system has been demonstrated to be well adapted for current collection from an overhead conductor under all conditions met with on American railways; it is reliable and economical in upkeep.

The success of the 3,000 volt direct-current system, as regards current collection, seems less certain and remains to be demonstrated for some of the difficult conditions that must be met; difficult current collection is undeniably a handicap to the success of this particular electric system and will weigh heavily against its adoption as a standard unless some overwhelming advantages of another nature are possible in the way of future perfection of direct current apparatus which will outweigh the present and probable future advantages of the alternating current system.

Substations

The alternating current system substations contain transformers which alter the voltage of the current only, and the switching and safety apparatus to control it. Substations of this kind are relatively simple, as they contain no moving apparatus and require only occasional inspection and attention.

Direct current systems require transformers, switching apparatus for the high tension current and rotary converting apparatus to change it into direct current; also, low-tension switching and safety appliances. This combination of apparatus is relatively costly and complicated and requires attendants at all times. It has been proposed to do away with constant attendance by installing automatic means, controlled by the load conditions, to cut the apparatus in and out of circuit. A description is entirely too technical for insertion in a report of this kind but it may be said that automatic substations have been employed for interurban traction work and are in process of development. It is too early yet to pass upon the results obtained or to assign a definite field for their use. The control mechanism is necessarily complicated, delicate and expensive and probably has serious limitations as regards its use for important traction installations on steam railways. It is possible they may be used in these cases, but as an adjunct only, to assist and simplify the work of the regular attendants in emergencies.

Standardization and Power Supply

Until recently, in America, there has been no concerted action looking to the standardization of the important features of any system, much less fixing upon any one system as a standard for all work. But at the present time this question has been brought very much to the fore.

There exists no sufficient and comparable operating data covering all kinds of traffic from which to conclude as to the relative advantages and disadvantages of the two systems most generally advocated today, i.e., the "alternating" and the "direct" current.

It is too early in the state of the art to determine and fix the features of any one system to the extent required for purpose of useful standardization without restricting the future and desirable development of the system selected. For instance, if the high-tension direct current system should be decided upon as standard, no practical advantage would result unless the voltage should be fixed; no one knows, however, at present, what voltage should be adopted as a finality for this system and a change in a voltage once established is a serious matter in a direct current system, as it would make obsolete practically all features of an installation in use.

Neither system, as now developed and applied to a typical general case, differs greatly in first and operating costs.

There is danger in endeavoring now to arrive at one standard system, of being unduly influenced in favor of one which is at the time enjoying the greatest use, and which may have been the only one available at the time of installation. An example of a system which operates well but which is conceded to be already out of date for certain kinds of railway usage in America is the 600 volt direct current third rail system. Main line railroads here are no longer seriously considering the third rail in any form for important main line electrification work. This system is however, the one most perfectly developed as all features and details have been thoroughly tried out and weak points eliminated. But it is the realization of its limitations which has caused inventors to work to higher voltages and by so doing to get away from the third rail and back to an overhead working conductor system.

Assuming that the above statements are well founded, and the writer believes from his experience that they are true, it would appear that the development of electric systems is proceeding along normal and logical lines at present and that there is no reason to force a conclusion at this time by hasty action in any direction. However, there is some reason to feel that this orderly consideration of the subject will not continue because of the views which are being generally expressed by those who are not engaged in operating the railways but are connected with other industries. To be explicit, because this is necessary, to clearly explain the situation of the two great electrical manufacturing companies in America, one is committed at present to the advocacy of the direct current system, and does not offer train equipment for the alternating current system; the other company has been responsible for the development of the alternating current system and advocates its use, but will furnish direct current apparatus if the customer prefers. The telegraph and the telephone companies are unfriendly to alternating current traction because they believe this system may cause them expense or difficulty to prevent inductive effects from the traction current. The commercial central power companies appear to consider it to their interest to advocate the use of direct current traction as the easiest system for them to supply power to, and they are now beginning to plan for the future railway power business. In explanation of this attitude these power companies find it advantageous for their commercial lighting and power loads to use 60 cycle current; this frequency is suitable for direct current traction, but cannot be used for alternating current traction in the present state of the art, without changing the frequency locally, which means added expense, hence they are opposed to the latter system.

While the above interests have decided views and are expressing them, the railways who must use the apparatus have not considered it necessary to actively advocate any particular electric system; they are trying out what they have got and are awaiting further information. Electrical engineers, competent to pass upon the operating as well as the technical aspects of the question, are not very numerous nor very influential, as compared with the powerful interests which are taking a decided stand upon the subject, and engineers are, furthermore, divided in their views upon the question.

The writer wishes it to be understood that he does not wish to advocate any one system to the exclusion of another, and favors a further trial of both the alternating and the high tension direct current system. However, it will be apparent from what he has said in this report that he considers high tension alternating current to have at present the greater number of demonstrated advantages for general railway use and to hold out the most promise for the future. Therefore, if it is thought necessary to standardize now, it would seem to him illogical to select the high voltage direct current system which had not

yet been applied to all railway operating conditions, and which appears difficult of application to some, and to discard a system which has been so applied and is operating economically and well in all cases.

Some Factors Controlling the Selection of System

The major considerations in the selection of an electric system are first and operating costs, reliability, flexibility and the promise of future improvements in all of these respects. There are other factors which have influenced engineers to a greater or less extent in expressing preferences for a certain electric system; they are really minor matters, as regards the whole problem, but have at times been magnified into major considerations.

One of these factors is the question of inductive effects in the nearby communication wire lines (telephone and telegraph). This is a troublesome matter, arising under certain conditions with all traction systems, especially from those not properly installed, but is much more costly to overcome in case of the alternating current systems than with the direct. A discussion of its causes and the remedy would be highly technical and therefore, outside of the province of this report. Efficient remedies can be applied; they require the co-operation of the railway and the wire-line companies and cause some expense to both. The cost as regards the railway installations is not prohibitive and has been allowed for in statements made as to the relative costs of the a. c. and d. c. systems. The costs, to the commercial companies, also, will generally not be great. It is believed that progress in the methods of construction of communication lines and apparatus, which is taking place for other reasons in the more settled portions of the country, will make this apparatus practically immune from inductive disturbance, and will thus remove the more serious cause of apprehension. Certainly "scare" agitation should not be allowed to stop progress in improving railway transportation.

Another factor is electrolytic effects on nearby underground metallic structures, pipe lines, etc. This is also a troublesome matter, but it occurs only in connection with direct current systems. Electrolytic troubles can be overcome by adding suitable appliances at moderate cost to the electric installation and by constant care in its operation. Such defects are more serious than generally supposed, because they are hidden from view until considerable damage has been occasioned.

Reliability

Experience with electric traction has been sufficiently long and extensive to show conclusively that in spite of the fact that it involves a complicated chain of apparatus to make centralized power available at the trains the method is astonishingly reliable and serviceable. But it is quite possible that one type of apparatus may be better than another in respect to reliability and an examination of the records of apparatus failures and train delays in cases of the different installations should throw some light on the matter. Unfortunately, records available are neither complete nor to be readily interpreted, and interpretation is further complicated by the fact that apparatus failures may in the case of one road cause delays to many trains whereas in another only one train may be delayed, depending upon the density of the traffic, the length of the line equipped, etc. In some cases, moreover, the records do not show delays unless the train is late in arriving at its terminal, while in others delay may be recorded as of the time required to remedy the defect, regardless of its effect upon train detention. Again, failures are very erratic in their frequency from year to year, especially those due to the power and distribution apparatus. The above illustrates the danger of generalizing from short-time records of any one installation, and the very great difficulty of arriving at a comparison of different installations and systems.

A careful examination of the reports from some of the important installations, for which figures are available leads, however, to the following conclusions as to the features which give most trouble in maintenance and which are the most frequent causes of train delays in operating the three different electric systems in general use.

The 600 Volt D. C. Third Rail System

Failures of old type circuit breakers, due to heavy short-circuit currents when the system is connected to generators of large capacity, make the old type of breaker unsuitable.

Occasional insulation failures occur on the overhead transmission lines, due to lightning discharges or to foreign objects fouling the wires.

Failures of high and low tension underground cables occur due to electrolytic corrosion of the lead sheaths and also same failures of telegraph and telephone cables.

Displacement of third rail occurs due to breakages of contact shoes, etc., also breakdown of insulation of the "jumpers" or connecting cables and failures of the shoe-contact, during very heavy snow or sleet storms; all inherent with this type of contact-conductor for cross country lines.

The usual and minor troubles occur with car equipments chiefly with control details and the "jumpers" between cars, some due to defective maintenance and others inherent with any complicated apparatus.

The High Tension Overhead Trolley Direct Current System

Experience with this system has to date been mainly with two installations, the Butte, Anaconda & Pacific and the Chicago, Milwaukee & St. Paul. In both of these operations there is freedom from the unfavorable conditions attending steam locomotive operation over the electrified lines; and they are thus not entirely typical of the conditions which must, for a time at least, surround electric operation generally. Furthermore, it has not been possible to obtain at the date of this report full information as to the actual results from these particular installations.

The main troubles experienced appear to have been:

1. "Flash-overs" at the commutators of the traction motors, due to the high voltage of the current and perhaps to voltage surges on the line;

2. Flash-overs in the motor-generator sets used for the control auxiliary apparatus on the locomotives, due to similar causes. Also other control troubles, probably due to insufficient development

3. The usual minor failures in apparatus in some part of the system due to a variety of causes, some of which are chargeable to imperfect developments, and others to "man-failures" which must occur from time to time in every phase of railway operation;

4. Occasional troubles in the overhead contact system, due to breakage of wires, fouling of the pantograph, insufficient contact and burning off of wires.

5. Failures of the mechanical portions of locomotives, due to insufficient experience in the design of a heavy-traction machine, also perhaps inherent in some of the types selected.

These several kinds of failures do not indicate that the system is fundamentally unsuitable, but on the other hand it must be said that the information obtainable is not sufficiently full and experience with the system not sufficiently extended to permit final judgment as to the extent to which the weaknesses peculiar to the system may be corrected by future perfection in apparatus.

No experience has been had with current collection at this voltage from wire lines which are corroded or coated from the operation of steam locomotives, and experience elsewhere with 11,000 volt current collection indicates possibly serious difficulty in successfully maintaining under these conditions an overhead contact system from which relatively large currents must be drawn.

No experience has been had with multiple unit car equipments for 3,000 volts, and it appears quite reasonable to anticipate much difficulty in overcoming the inherent tendency for small motors to "flash-over" with high voltage used on the commutators. Certainly the difficulty of maintenance of high voltage motors and high voltage in and around the control must be greater than is the case with multiple-unit equipments for the 600 volt direct current system.

Alternating Current System

The principal failures in the case of the mono-three-phase system, such as is used on the Norfolk & Western Railway, have been in the mechanical features of the locomotives which were in some particulars too light for the service. These failures were, however, in the nature of development defects and are not in any way peculiar to the system of traction. Electrical features of these locomotives have also given some trouble, under the severe service requirements. Some of these electrical troubles are directly chargeable to the mechanical defects of the locomotives, and others were due to the use of apparatus of a design which had been found suitable in shop power plants, but which developed weaknesses when put on locomotives; no inherent defects, however, have developed which are not susceptible of correction.

As regards the other features of this traction system; the line construction, the substations and the power house, these have operated in an extremely satisfactory manner and demonstrate that the maintenance of these features is attended with no undue difficulty.

In case of the multiple-unit single-phase installation on the Pennsylvania at Philadelphia, the principal difficulties experienced are as follows:

1. Circuit breakers in the substations have given considerable trouble from insufficient rupturing capacity, under the local condition that this installation derives its power from a very large central station; thus, under short circuit conditions, the magnitude of the current to be broken may reach very high figures. The same remarks apply to the transformers and failures have occurred from the same general cause. In other words, neither of these appliances has been made rugged enough;

2. There have been failures in submarine cables connecting the power house with the traction system; these were due to the local situation and not to the kind of traction system used;

3. Breakdowns of insulators of transmission lines under low bridges, due to the great amount of steam operation on the electrified tracks these wire lines are now run over the bridges;

4. Corrosion of the steel messenger and other parts of the catenary structures due to steam operation. Also, cases of pantographs fouling wires;

5. Short circuits caused by "man failures" in switching; also by pieces of wire, etc., thrown upon the transmission lines or the catenary structure; this is a difficulty experienced with all traction systems, to an extent determined by the local conditions.

The car equipments have given very little trouble, certainly not more than normal; the a. c. motor is demonstrated to be serviceable and reliable.

Experiences with the single phase system on the New York, New Haven & Hartford Railroad have been of a similar character, but its reliability there has suffered somewhat in comparison with the installations elsewhere, due to the fact that it is a pioneer example of heavy traction and is, moreover, complicated by the necessity of adapting its apparatus for operation over the direct current lines of the New York Central Railroad.

Flexibility

This means adaptability to all kinds of railway service, and the prospect of the greatest progressive improvement in the future to meet the changing requirements of railroad operation. It is the necessity for all these that has caused the development of the high tension overhead-contact systems. The third rail system, which started successful electric traction on steam railways, has shown excellent and economical service on short lines with heavy traffic, and no system has yet been devised which is superior to it in reliability and none have reached it in perfection of detail. However, it is not flexible and economical for indefinite extension and, as before stated, is giving way to others for new work.

Of these other systems now available (the high tension direct current and the alternating current) it is not yet apparent that the high voltage direct current system, which is similar in many of its characteristics to the third rail system, possesses the elements of flexibility and adaptability for all kinds of railway service to the degree that these are present in the high tension alternating current system. It is however, too early to predict which of the two systems will ultimately have the greater number of essential points in its favor, and it would be extremely unfortunate, in the writer's opinion, to eliminate either from further trial and application to new work, and it is to be hoped that the views of those outside of the railway operating field will not be given undue weight to the end that progress in the development of either system shall be stopped prematurely.

The weight of a round bar increases as the square of the diameter, the bending strength as the cube and stiffness as the fourth power. Therefore if the diameter of such a bar is doubled the weight will be four times (2 x 2) as much, the bending strength eight times (2 x 2 x 2) as much and the bending stiffness sixteen times (2 x 2 x 2 x 2) as much the original bar.

Principles of Car Lighting by Electricity

A Course of Practical Lessons Explaining the Main Details of This Important Application

By Charles W. T. Stuart

XVIII.—Stone-Franklin Car Lighting Equipment

THE Stone-Franklin car lighting equipment consists of a generator, driven by a belt from the car axle, automatic panel, and main light panel board, mounted in a cabinet inside of the car, and a storage battery which is suspended in a box under the car body.

The fundamental principle of the Stone-Franklin system is a modified watt control of the battery charge which results in a straight line charge through the whole of the charging cycle followed by a period in which the battery charging rate is reduced to within a safe limit. The battery charging rate is reduced when the counter electromotive force of the battery reaches its maximum value with 1 1/3 normal rate of charging current flowing through the battery. The modified watt control of the battery charge is nothing more than a combination of battery voltage plus battery current control. For example, starting with a fully discharged battery, assume that the generator is delivering a charging current to the battery that is held constant at first at 45 amperes. The counter-electromotive force of the battery increases as the battery charges and accordingly the generator output changes quantitatively, the current tapering as the back e. m. f. of battery rises. As the charge proceeds the generator voltage increases sufficiently to compensate for the gradually increasing battery e. m. f., but owing to the watt control of generator output the charge rate slowly tapers and the increase of battery voltage is therefore held within definite limits. This increase of battery and generator voltage continues until the generator voltage has risen to approximately 39 volts for a lead battery; then the combined effect of the 39 volts and the then prevailing charging amperes automatically reduces the battery charging rate to within safe limits, slightly below normal rate.

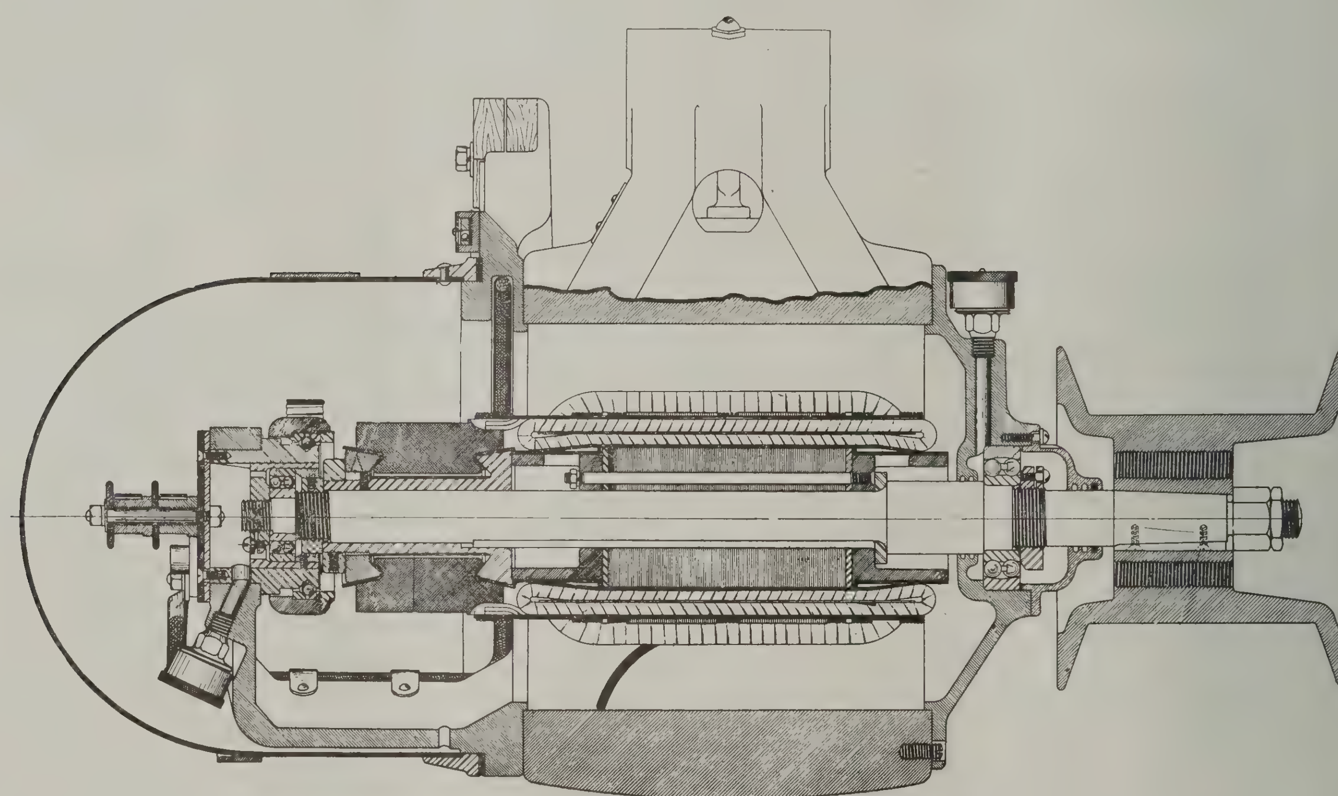


Fig. 1—Cross-Sectional View of the Stone-Franklin Type T-35, 40-Volt, 40 Ampere, Generator

This action of reducing the battery charging rate after a certain state of battery charge has been reached, assists the regulation of the lamp voltage by eliminating excessive generator and battery voltages.

Generator

The generator, shown in Fig. 1 and 2, is a shunt-wound machine designed to give sparkless commutation through the range of loads and speeds met with in car lighting. The Stone-Franklin generators are suspended from the car body and made in two sizes as follows:

Type 35, 2-pole, 1.6 kw. Capacity.
Type 50, 4-pole, 3 kw. Capacity.

The main parts of the generator are as follows—

magnet frame, pole-pieces, field coils, armature, bearings, pole-changer, brush holders and brushes.

Of special interest is the pole changer on which the flexible leads are brought out beyond the brushes thus eliminating troubles with leads catching brush holders. Destructive flexing of leads is also eliminated by an arrangement which permits the flexible leads to wrap around circular terminal posts.

STONE FRANKLIN GENERATORS

	T-35	T-50
Rating	1.6 kw.	3 kw.
Amperes	40	75
Volts	40	40
Cut in speed r.p.m.	20	18
3/4 Load speed r.p.m.	22	20
Full load speed r.p.m.	23	21
Weight of generator without pulley	310 lb.	480 lb.
Weight of armature	45 lb.	100 lb.

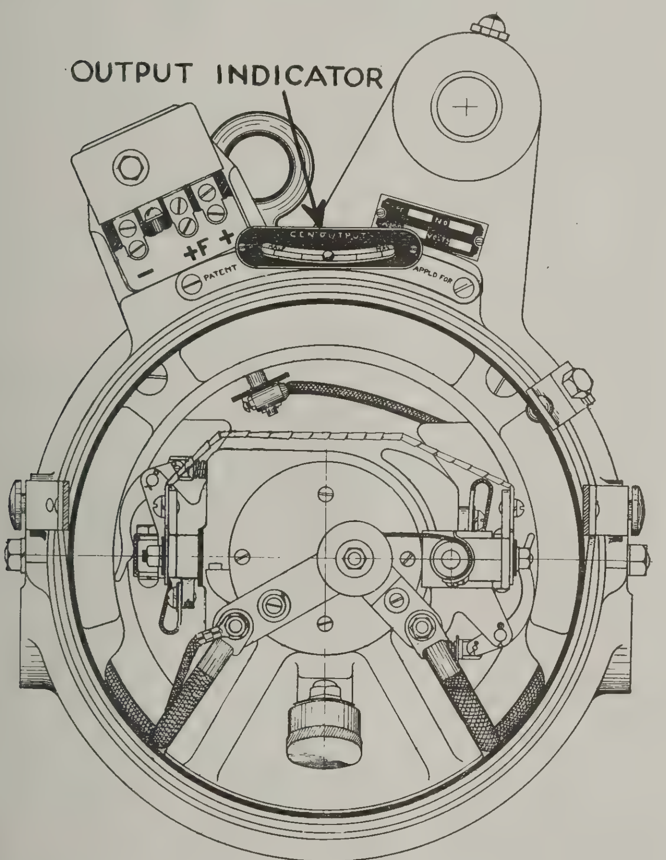


Fig. 2—End View of Same Generator as in Fig. 2 Showing the Output Indicator

The armature pulley for the Type 50 generator is 5½ in. in diameter.

The armature pulley for the Type 35 generator is 4½ in. in diameter.

For special low speed conditions, the T-35 generator is operated with a 3½ in. pulley.

The face of the armature pulleys used with the Stone-Franklin equipment is straight and must not be crowned.

Automatic Panel

The automatic panel, Fig. 3 is fitted with an automatic switch, reducer switch, and a relay switch.

In order to effect standardization of individual cells, the Stone-Franklin system has been designed to operate with either a single unit battery or a double unit battery, which gives the opportunity of standardizing on the one type and size cell. For instance, a 200 ampere-hour battery can be used for coaches, or any other class of car having a lamp load up to 20 to 25 amperes, while the same type and size of cell can be used for dining cars and other classes of cars having double that lamp load by using two sets of this type of battery in multiple. In such cases an automobile change-over switch is used to alternate the two battery units on the generator for effective charging. The Type AR panel is used for single battery operation, and the Type ARD panel is used for double battery operation.

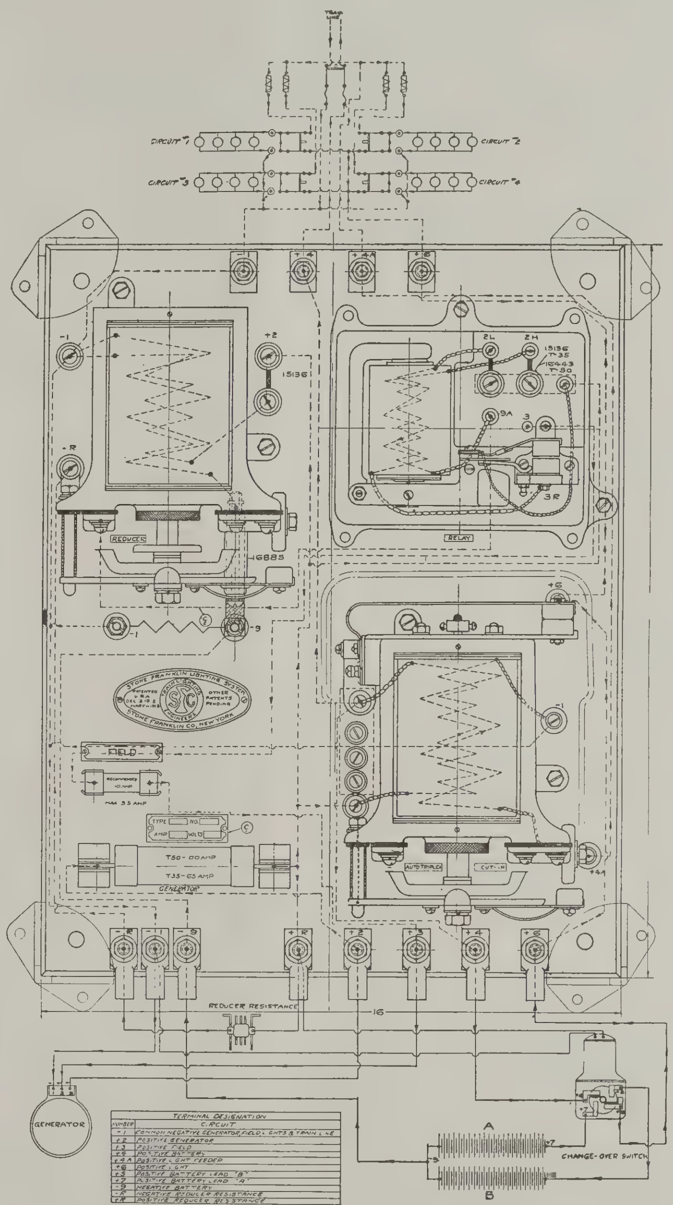


Fig. 3—Type A R D Automatic Panel for Double Battery Equipment

Operating Features

The generator is regulated by limiting the belt tension so that when the desired output has been reached, the belt pulls the generator toward the axle pulley and the armature continues to rotate at practically constant speed, regardless of increase of train speed. A change in the external resistance of generator load will cause slight

variations of the armature speed, as this mechanical control virtually results in constant torque, permitting the generator voltage to adjust itself automatically to the various conditions of the battery.

The belt tension, therefore, is very important, and adjustments should be made in accordance with a table.

The belt tension is adjusted by the use of an output indicator which is fitted to the front head of the machine as shown in Fig. 2. This indicator operates on the principle of a spirit level, and translates the pull on the belt into terms of output. The tension is effected entirely by a portion of the generator weight, and no springs are used. By operating the hand wheel on tension rod of the suspension link, Fig. 4, the belt pull can be increased or decreased as desired, and the setting of the belt tension should be in accordance with the following table.

Set Output Indicator at:

On T-50 with Lead Batteries
150 A. H. 2 degrees below full.
200 A. H. 1½ " " "
250 A. H. 1 " " "
300 A. H. ½ " " "
350 A. H. Full.
On T-50 with Edison Batteries
A-4-H 1 degree below full.
A-6-H Full.
A-8-H 1 degree above full.
A-10-H 2 degrees above full.
On the T-35 with Lead Batteries
150 A. H. ½ degree below full.
200 A. H. Full.
250 A. H. ½ degree above full.
On the T-35 with Edison Batteries
A-4-H Full.
A-6-H 1 degree above full.

If the T-35 generator operates with 3½ in. pulleys, belt tension must be increased so that indicator reads 1

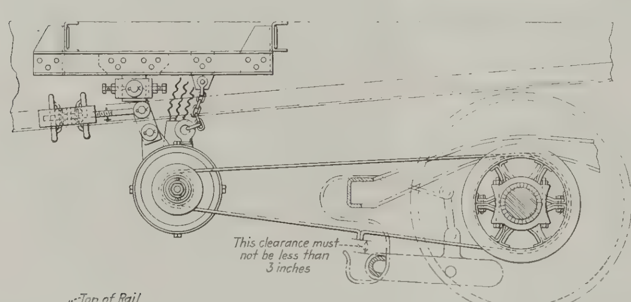


Fig. 4—Standard Application of the Stone-Franklin Equipment

degree above values given. This applies to both lead and Edison batteries.

Operating With Sulphated Battery

Due to the mechanical control of generator output, which results in constant torque, a sulphated battery is automatically taken care of as its high internal resistance simply causes the generator voltage to increase, and thus a moderate charge passes through the battery. This is readily understood from the fact that the generator voltage with this control is dependent, first, on the back e. m. f. of the battery, and, second, its internal resistance, and as the watt output of the generator must remain practically constant, it again follows that the charge rate will be automatically reduced.

Operating With Discharged Battery

For the above reasons a discharged battery will receive at the beginning a heavier charge rate up to a certain gassing point, because of the low back e.m. f. of such battery. As the battery voltage rises, the rate of charge will gradually taper off. The belt tension settings given in above table are based upon maximum charge rates for the various batteries which continue, however, only until gassing sets in, when the reducer switch, described later, functions and so cuts down the battery charge to normal. As the battery reaches full state of charge, with this normal rate, the relay comes into action, and through

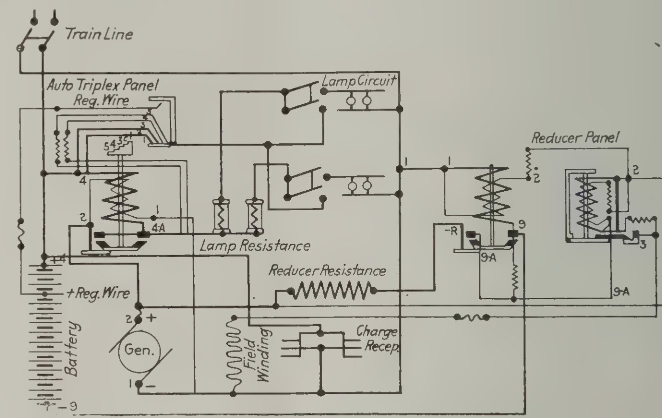


Fig. 5—Schematic Wiring Diagram for Single Battery Equipment

its functions, disconnects the generator entirely from the battery.

Battery Control

The battery itself, that is, its own characteristics, are used to determine the full state of charge. The battery governs the regulating apparatus and influences the generator quantitative output, in accordance with its state of charge. The apparatus, therefore, when once calibrated and adjusted, for a given type of battery, cannot get out of step with the charge of battery. To insure at all times a fully charged battery, the charge rate for

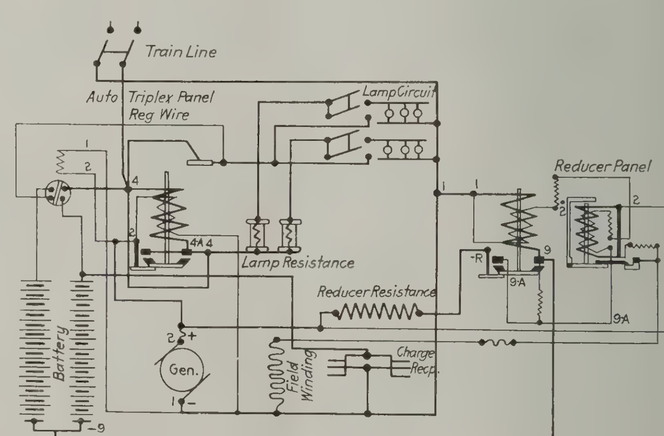


Fig. 6—Schematic Wiring Diagram for Double Battery Equipment

a given battery at the initial stages of charge, is set for approximately twenty amperes above normal rate, and permitted to flow through battery provided it is in a receptive condition, until gassing sets in.

Reducer Switch

At the gassing point of battery the reducer switch, operating on the principle of watt control, functions in the following manner;

A shunt coil, which is virtually connected across the battery, when the main switch is closed, furnishes a definite number of ampere turns, which tend to operate the reducer switch. A series coil carries the battery charging current. The resultant ampere turns, therefrom, further assist the shunt coil. Is is therefore the combined ampere turns of both battery voltage and battery current which cause the reducer switch to act and the combination is so proportioned that the gassing point in any type of battery can be effectively determined. When this point is reached, the reducer switch closes, and by completing a circuit through reducer resistance, a portion of the initial rate is absorbed and the battery now continues to be charged at normal rate until a definite voltage with this definite normal charge rate is reached.

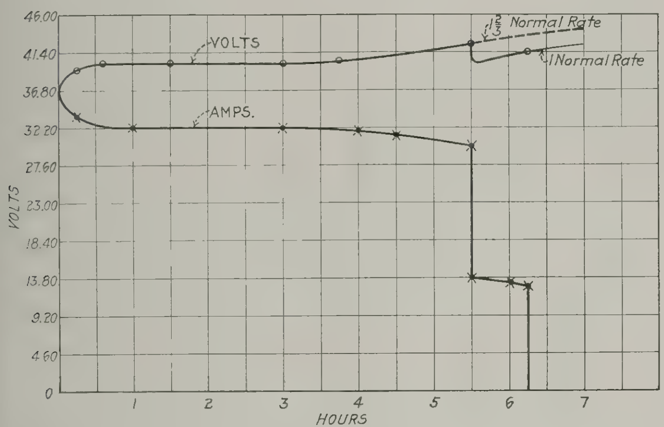


Fig. 7—Charging Current and Voltage Curve of Edison Battery

Relay Switch

Through the closing of the reducer switch, the lifting coil of the relay switch has been strengthened through the short-circuiting of a resistance tube in series with lifting coil, and the relay switch is now calibrated to operate when the battery has reached its final voltage with the low charge rate. As soon as the relay armature lifts, a field resistance of high ohmic value is inserted in the generator field, and this action practically kills off the generator as it can only furnish approximately 5 volts regardless of train speed. Both main and reducer switches immediately drop out, and the generator, therefore, is entirely disconnected from the battery. The generator voltage, however, although only 5 volts, is sufficient to hold the relay armature until the train speed decreases to below ten miles per hour. When relay armature drops, and the equipment is restored to normal operation.

Lamp Voltage Regulation

The lamp current is furnished by the generator, through suitable iron wire resistances enclosed in vitrous enamel to prevent deterioration. These resistances serve to reduce this supply current to the desired lamp voltage. To simplify the correct apportioning of these resistance units for a given circuit, the resistance unit has been given a number which corresponds to the wattage of the lighting load for which it will give correct regulation. For example, resistance unit No. 120 is suitable for a lighting load of 120 watts. Therefore, for a lighting circuit of 240 watts, two units should be placed in parallel, etc. Where the wattage of a given lamp circuit is not an exact multiple of 120, the nearest multiple of resistance units should be selected. For instance, for a lamp circuit of 400 watts, the correct lamp resistances would be three No. 120 units.

The lamp voltage is further stabilized by a suitable and accurate floating voltage. In case of single battery operation, this stabilizing voltage is obtained from a definite number of cells of the battery on charge, and this connection is automatically disconnected from the lamp circuit, when the stabilizing voltage falls below the required lamp voltage. This operation is performed by the cut-in switch through the medium of regulating finger No. 5 on top of switch. See Fig. 5.

In case of double battery operation, the stabilizing voltage is derived from the battery unit which is not being charged, and in the case the regulating voltage is permanently connected to the lamp circuits. As the two units are constantly alternated by the automatic change-over switch on the generator, the regulating voltage is always obtained from a fully charged battery.

A Few Points on Adjusting

With the generator inoperative the lamp voltage is not more than ½ volt less than battery voltage. A greater difference in these readings is an indication that the finger contacts on top of main switch need cleaning.

The correct position for the suspension link is such that the generator suspension pin is 3 in. closer to the driving truck than the top suspension pin, and belt should be cut to proper length, so that this condition can be maintained.

The main switch is set to close at 30 volts, for both lead and Edison batteries, when lamps are switched off. With full lamp load on, the switch must close at 32 to 33 volts. The main switch will open or cut-out with a reverse current of 1 to 2 amperes with lamps on, and 4 to 5 amperes with lamps off.

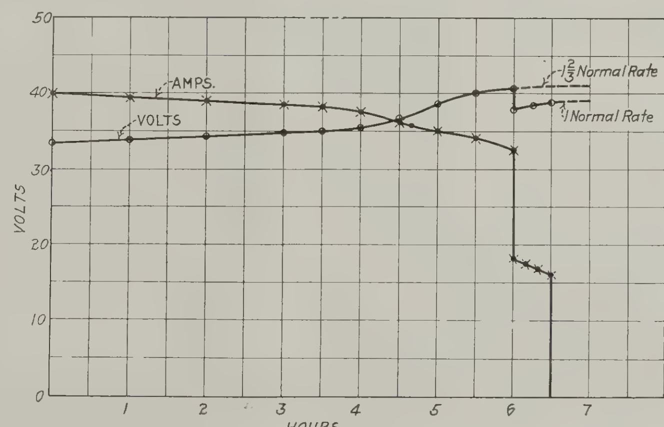


Fig. 8—Charging Current and Voltage Curve of Lead Battery

The main switch is adjusted by the nut at the bottom to the left, and by the top core located under the elevator block.

For single battery operation the main switch plunger must raise the fingers successively, No. 1 finger lifting when the battery receives a charge of 5 amperes. No. 2 finger with a battery charge of 10 amperes. No. 3 finger with a battery charge of 15 amperes. No. 4 finger with a battery charge of 20 amperes. No. 5 finger must make contact at the moment No. 4 finger breaks contact. The

elevator block is furnished with screwed pins of bakelite, to facilitate the necessary adjustment.

For double battery operation all five fingers must be raised at once, and the bakelite pins must therefore be adjusted evenly. The five fingers then act as a single brush, and must be lifted when the battery charging current is 12 to 14 amperes.

Reducer Switch

The reducer switch is calibrated on an open circuit without any current flowing through series coil. Permit the generator to build up its voltage on open circuit, by holding out main switch. The reducer switch must close on open circuit for lead batteries at 45 to 45.5 volts, for Edison batteries at 49 to 50 volts. Should adjustments be necessary, first set the nut at the bottom, so that the main brush tip is ½ in. from its contact, when the switch is open. Then adjust the top core until above results are obtained. The switch must drop out again at a generator voltage of not more than 22 volts. If switch drops out earlier, the carbon contacts will depreciate prematurely. To correct this, top core must be screwed down, and the cut-in setting corrected by screwing the bottom nut further down. Make sure the set screws are thoroughly tightened after adjustments have been made, that plunger moves freely, and that bottom nut is actually secured by its set screw.

To compensate for the various charge rates of different battery capacities, a shunt is placed across the terminals immediately below the reducer switch. This shunt is connected across the series coil of the switch, and in this manner the switch is calibrated for higher charge rates to suit the larger sizes of batteries.

Relay Switch

This switch is calibrated with the reducer switch closed to operate from 42 to 42½ volts with lead cells, and from 44 to 44½ volts with Edison cells. With reducer switch open, the relay operation will be retarded by some five volts, and in this manner the relay also serves as an open circuit protection. Set screws are provided for making adjustments.

Change-Over Switch

This switch must lift before generator voltage is 28, and the plunger should drop out again at 1 to 1.5 volts.

Belting

Frisco belting only should be used with the Stone-Franklin equipment. In case of an emergency, a rubber belt may be temporarily applied, by cutting the belt in two, and applying a two-inch belt.

Operation

Fig. 5 is a schematic diagram of a single battery equipment and its operation is as follows:

Suppose we assume that the battery in this case is a 150 ampere hour Edison (Type A-4H) and the generator is Type 35.

When the car is standing and generator inoperative, the current to the lamps is furnished by the storage battery. The lamp voltage in this case will not be more than ½ volt less than the battery voltage.

When the car is in motion the generator voltage will build up due to the residual magnetism of the field pole pieces. At slow speeds there is generated in the armature a low voltage which forces a small amount of current through four parallel circuits, comprising the lifting coil of the automatic switch, the field circuit, the lifting coil of the relay switch, and the shunt coil of the reducer switch.

While the lifting coil circuit of the relay switch and the shunt coil circuit of the reducing switch are alive at this time, they remain inoperative until the battery reaches a certain state of charge.

As the speed of the armature increases and the current in the field circuit increases the field magnetic strength, the generator voltage also increases until it reaches 30 volts when lamps are switched off, or 32 to 33 volts when all lamps are switched on, at which time the automatic switch connects the generator to the car wiring.

The instant the automatic switch closes, all circuits become energized, the machine furnishing current for all lamps that may be turned on, but delivering only a small amount of current to the battery. As the speed increases, the generator voltage rises and increases the battery charging current.

As the battery current increases the finger contacts on top of the main switch are lifted successively.

The output indicator on the Type 35 generator when operating with a A-4-H Edison battery should be set at "full," and since the Type 35 generator has a capacity of 1.6 kw., "full" on the indicator represents 1,600 watts. That is, the product of the volts and amperes equals watts. Such as, 40 volts times 40 amperes equal 1,600 watts, etc.

As the speed increases the generator output increases until it reaches 1,600 watts. At this point a further increase in train speed will only cause the belt to slip over the generator pulley, the armature speed and generator watt output remaining constant.

From the instant the generator starts to build up, the shunt coil on the reducing switch is alive but the current through it is not sufficient to produce the magnetism necessary to lift its plunger. However, the generator voltage gradually increases as the batteries become more fully charged, and this rise in voltage effects a corresponding gradual increase in the current through the coil, until the gassing point of the battery is reached. At this point, the combined forces of the shunt and the series coil of the reducing switch through which the battery charging current passes, are sufficient to operate the switch. The closing of the reducing switch reduces the battery charging current by connecting the reducer resistance in multiple with the battery. It also shunts a resistance unit out of the relay lifting coil circuit, which allows the relay switch to operate at a lower voltage.

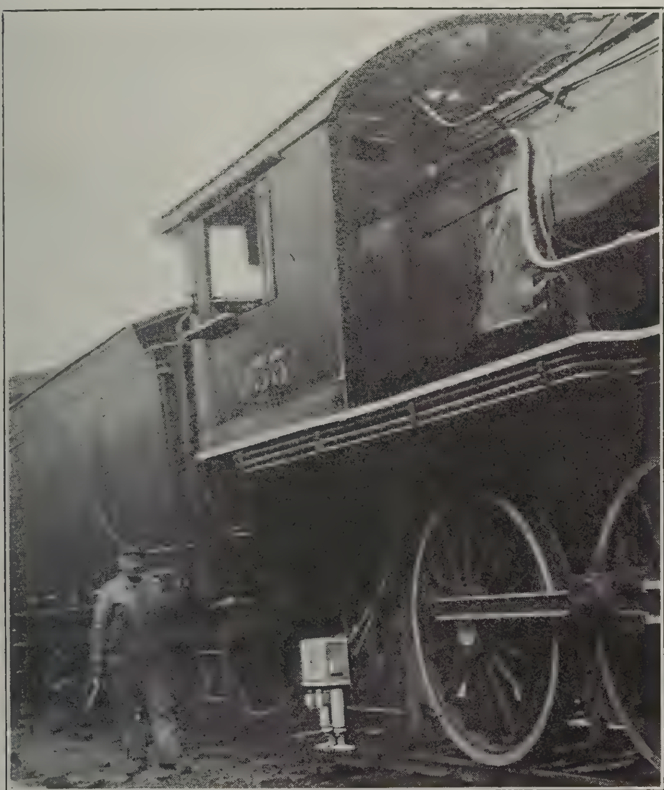
The battery charge will continue at the reduced rate until the voltage reaches approximately 44.5 volts, indicating a fully charged battery and closing the relay switch. As soon as the relay armature lifts, a field resistance of high ohmic values is inserted in the generator field, and this action practically kills off the generator as it can only furnish approximately 5 volts regardless of train speed. Both main and reducing switches immediately drop out, and the generator, therefore, is entirely disconnected from the battery. The generator voltage, however, although only 5 volts, is sufficient to hold the relay armature until the train speed decreases below ten miles per hour, when relay armature drops, and the equipment is restored to normal operation.

Figs. 7 and 8 are charging current and voltage curves of Edison and Lead Batteries, respectively.

Recent Tests of Train Stops and Controls

Mechanical Contact and Induction Apparatus Prove Their Efficiency as Protective Devices

EXPERIMENTS have been going on for some time on the Erie Railroad with an automatic train stop and these have now been completed to the extent that arrangements have been made by the manufacturer of the apparatus, the International Signal Company, of New York City, for testing the stops extensively between



Automatic Stop Apparatus on Locomotive 955

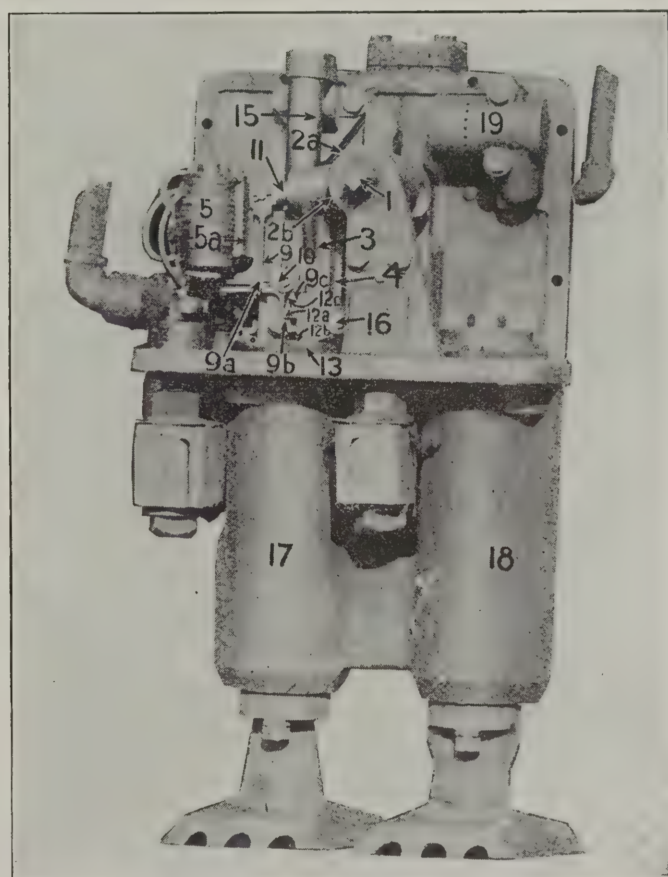
Englewood, N. J., and Fairview. This is on the Northern Railroad Division, about 10 miles from New York City.

Under this arrangement with the railroad company, the signal company is installing additional fixtures on both the eastbound and westbound tracks and has equipped locomotives No. 955 and No. 957, which are used on local passenger trains regularly between Nyack, N. Y., and Jersey City, N. J.

Preparatory to equipping the additional locomotives and additional block sections, an exhibition of the operation of the stop was made recently for the benefit of a party of officers of the road; and a summary of these runs is given below.

THE WEBB AUTOMATIC TRAIN STOP

This apparatus, which was first tested in March, 1917, on the New York, New Haven & Hartford, is of the intermittent contact type, the ramp, 34 ft. long, being fixed 17 in. outside the running rail. The shoe on the locomotive, supported on the frame behind the driving wheels (or on the trailing truck if there be one) is lifted, and causes the opening of the air brake train line, at every ramp, but if the block section to be entered is clear and its track relay closed, an electric circuit, controlled by this relay, and extending through the ramp and the shoe, actuates an electro-magnet on the locomotive which immediately closes the air valve, before the triple valves have been affected; and the only effect of the lifting of the shoe is to exhaust enough air to sound a blast of about one second on a whistle in the cab. In other words, there is a proceed indication at each ramp approaching a clear signal. If no electric current is received from the roadway (indicating that the road is not clear to proceed), the exhaust of air sounds a blast on the cab whistle, which continues until the brakes are set, or until the engineman



Webb Automatic Brake-Setting Machine

closes the valve, as he may do when he sees that his speed is sufficiently reduced.

There have been but few changes made in the detail of this apparatus since 1917. The cam shaft 1 and the main cam 2, have been made hollow and connected with the train line air. The plunger head, 3, with its contacting projection, 4, have also been made hollow and connected with the train line air so that now each portion of the apparatus that is used in the valve-opening operation is so designed that its breakage or removal would exhaust the train line air to the atmosphere. The armored hose has been superseded by a stationary piston, 15, for connecting

the train line air with the plunger head, plunger and shoe. The magnet bracket, 5*a*, is now made an integral part of plunger head 3. The path-clearing plunger 18 has now been made an integral part of the box design. The manual reclosing operation is now accomplished through cylinder 19 and its piston, instead of the slide formerly used.

As the train-carried fixture passes over the ramp, the operating plunger is lifted vertically and projection 4 engages cam projection 2-*A* oscillating the main cam, 2, with its shaft, 1; opening the air valve by means of the valve cam which is also fixed on shaft 1, so that the train line is vented to the atmosphere. If the track relay is in the stop position no further action takes place; and as the plunger resumes its normal position, after passing the ramp, the air valve remains open and the train is brought to a stop in the usual manner.

If, however, the indication is clear, the electric current controlled by the track relay energizes magnet 5 and causes the bolt lever, 9, to project the bolt, 11, so that in the downward movement of the plunger the bolt restores the main cam and air valve to their normal positions and no braking action takes place. Both the opening and closing of the air valve are direct mechanical operations.

In this installation on the Erie Railroad, there is no distant signal or line relay. The circuit to the ramp, which is located approximately 1,600 ft. in the rear of the signal, is controlled by the track relay and a circuit breaker operated by the signal itself.

Details of Tests

The tests referred to were nine in number, eight as scheduled and the ninth to take the place of the fourth, as explained below. They were made with locomotive No. 955 and eight steel coaches, some of the runs being made, however, with a five-car train.

Test No. 1—Semaphore at stop; ramp passed at full speed as if the engineman were dead. Speed at ramp 40 miles an hour; train stopped, against steam, 1,113 ft. after passing ramp and 493 ft. short of the semaphore.

Test No. 2—Semaphore at stop; ramp passed at full speed. Brakes automatically applied, but before the train came to a stop the engineman, with the optional release, re-closed the air valve, this to save time and to avoid unnecessary stopping and starting, as would be the case with a long freight train. The engineman closed the valve about 800 ft. from the ramp and coasted to the semaphore, where he stopped by using his brake valve.

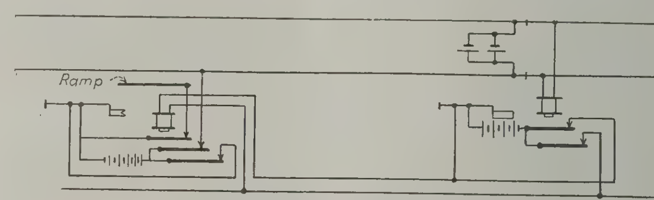
Test No. 3—Eight-car trains; speed at ramp 37 miles an hour; train stopped automatically 419 ft. short of the signal.

Test No. 4—Semaphore at stop; ramp passed at full speed. As soon as the audible indication in the cab showed that brakes were being applied, the engineman made an emergency application with the engineer's valve.

Speed of train at ramp 40 miles an hour; train stopped automatically 974 ft. from the ramp and 632 ft. short of the semaphore. In this test both of the contact shoes were broken off when they came in contact with the ramp rail, evidently because of imperfections in the castings and their worn condition due to previous use. On account of the shoes breaking before they had reached a point on the ramp rail sufficiently high to raise the operating plunger, no audible signal was given in the cab. The train, however, came to rest automatically, as stated above, the breaking of the casting serving to exhaust the air from the train line. New shoes were put on and the tests continued. During the preparation of the program for the tests, the advisability of interposing an obstruction that would break the contact shoes was feebly discussed, but it was finally decided to omit such a test, because of the possibility that the obstruction might result in damage other than the breaking of contact shoes. Therefore, this breaking of the shoes under normal service conditions provided a specially interesting demonstration.

Test No. 5—This was simply to demonstrate the audible "proceed" indication.

Test No. 6—In this the semaphore was left at proceed, but the roadside battery was disconnected; speed at ramp 45 miles an hour; train stopped automatically 448 ft. short of semaphore.



Electric Connections Between Signal Circuits and Ramp as Originally Used By the Webb Service

Test No. 7—Semaphore set in proceed position; magnet wire disconnected from binding post or plunger-head of engine apparatus. Speed of train at ramp 45 miles an hour; train stopped automatically 431 ft. short of semaphore.

Test No. 8—Semaphore held in the proceed position by mechanical means, and track relays de-energized. This was to illustrate the case of a false clear visual signal.

Test No. 9—Repetition of test No. 4 as originally planned.

All of these tests were satisfactory. Both the railroad and the manufacturers had special inspectors on the train, and on the ground to make detailed written notes of each test.

"M-V ALL WEATHER" TRAIN CONTROL

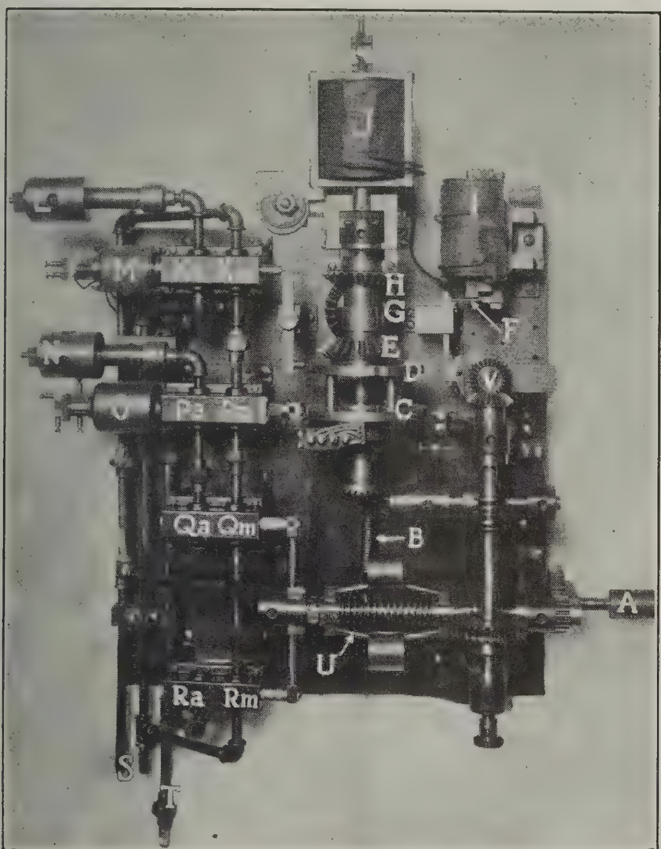
Near Parlin, N. J., four miles west of South Amboy, on the Raritan River Railroad, the M-V All Weather Train Controller Company, of Newark, N. J., recently gave an exhibition of its automatic train control before four or five hundred spectators, the party having been taken to Parlin in a special train over the Central of New Jersey and the Raritan River. A locomotive and five coaches were used and five tests were carried out satisfactorily.

This device is of the induction type with no contact between the locomotive apparatus and the roadway, and no moving parts in the roadway member. The valves controlling the setting of the brakes of the train are automatically opened at the approach to each block section, and the brakes are set, unless the valves are held closed, at that point, by what is equivalent to a proceed indication conveyed by induction from the roadway element. This periodical operation of the brake apparatus is accomplished by means of a cam which is revolved, slowly, by gearing actuated through a suitable connection to one of the front truck wheels of the locomotive. The scheme involves the division of the line of road into block sections of equal length, the gearing connecting the truck wheels and the cam or cams being so proportioned that the cam,

in its revolution, will have reached its brake-setting position when the locomotive has reached the point on the road where it is desired that the brakes should be applied. If there is no reason for stopping, or for slackening speed, the cam, by the influence of a magnet controlled from the roadway, is released, and before causing a brake application is reset at its starting point, to begin a new revolution, preparatory to causing a stop (if a stop shall be required) at the next point.

The air valves, controlling magnets and centrifugal governor (by which latter the speed of the train is made to control the setting of the brakes) are contained in a box fixed on the front of the locomotive and the photograph is a front view of these parts, the front cover of the box being off.

The collecting coil on the train is hung about 9 in. above the level of the top of the rails, being supported on



Brake-Setting Apparatus—M-V All-Weather Train Control System

a longitudinal beam beneath the center of the tender. The truck magnet is placed midway between the running rails, and the top of the box containing it is flush with the tops of the ties. The arrangement of the magnets of successive sections is shown below.

The scheme contemplates the use of blocks of a length which (including a suitable margin of safety) will correspond to the braking distance for the fastest trains; and the brakes of such trains, for stopping at the entrance of block *B C* will be applied at *A* (see diagram). Assuming the presence of a train in section *B C* the track relay at *B*, being open, holds open the wire circuit which energizes the track magnets at *sx* and at *ca*. A following train, if moving at more than 30 miles an hour, has its brakes applied at *A;* and at *sx*, if block *B C* is still occupied, another application of the brakes is made, to bring the train to a stop before it reaches *B*. The second brake-applying point *sx* is fixed at a sufficient braking distance short of *B* to stop trains traveling at restricted speed (30 miles an hour). Further details are not made public at this time; but Dr. Charles W. Burrows, consulting engineer of the controller company, has favored us with the description, given below, of the valve-actuating apparatus by means of which the train brakes are set.

The track equipment, taking, for example, block *B C*, consists of the caution magnet *ca*, the stop magnet *sx*, the track circuit relay at *B*, the track circuit relay at *A*, and the power line. The roadway circuit which energizes *ca* and *sx* (in series) includes these two track magnets, the back contact of the track circuit relay at *A*, and the front contact of the track circuit relay at *B*. Each track magnet is virtually the primary of a transformer. This circuit is normally open, due to the fact that the track circuit relay at *A* is normally closed. When this is opened by the approaching train and that at *B* is closed (no train in block *B C*) the track magnets are both energized, preventing the application of brakes.

If a train passing *A* finds the track magnet at that point (*ca*) dead, the fact indicates that there is a train in block *B C;* no magnetic impulse being received from the roadway, the cam causes the application of the brakes until the speed is reduced to the restricted rate (30 miles an hour). If the second magnet (*sx*) is dead (block *B C* being still occupied) the valve to cause a full stop is opened. To stop a train the track magnets must be dead; and to allow it to proceed—to prevent the setting of the brakes—must be energized.

The electromagnets on the roadway are of the horseshoe

Diagram Explaining the Operation of the M-V All Weather Train Control System

type, consisting of two cores arranged vertically, and a yoke of laminated silicon steel. This yoke is about 30 in. long and of 2 in. x 2 in. section. The vertical members are about 8 in. x 8 in. The magnetizing coils, surrounding the cores, are energized by a 60-cycle alternating current. A magnet consumes, when operating, 30 watts.

The locomotive collecting coil is fixed on a bar of laminated steel fastened under the tender, and it constitutes the secondary of a transformer, the winding of the roadway element being the primary.

In the photographic illustration of the cab mechanism, *A* is the connection to the wheels of the locomotive and *U* is the centrifugal governor operating the two sets of valves, *Qa-Qm* and *Ra-Rm*. The continuously rotating element is indicated by *V* at the top of the vertical shaft at the right. The armature of the relay is indicated by *F*, shown resting against the detent of the lever; and the magnetizing solenoid is indicated by *I;* this is in series with the coil beneath the tender The clutch member and the rotating switch are directly behind the miter gear *V*. The two cams, *C* and *D*, are driven, as shown, through a train of gears.

At the top of the picture is shown the cam-resetting magnet *J;* this is energized from a storage battery, the current of which is controlled by relay *I*; and when energized pulls up its armature, and with it the miter gear *H*.

This gear rotates continuously whenever the locomotive is in motion, and is free to slide upon its shaft. Normally, *H* engages the gear *G* which in turn drives the gear *E*. This latter is rigidly attached to both cams so that whenever the gears are in the position shown and the locomotive is in motion, the cams are rotated.

When the magnet disengages *H* from *G*, the cams cease to revolve and the spring *B* restores them to normal position. In this position the cam system remains at rest until the re-setting magnet is de-energized and the gear *H* again engages *G*.

On the left of the photograph are four pairs of air valves, *Ra-Rm; Qa-Qm; Pa-Pm* and *Ka-Km*. Each controls two passages; one, designated by *a* is between the atmosphere and the engineer's valve reservoir (through the pipe *T*); the other *m*, connects the two sides of a differential air valve (through the two pipes *S*). The action of this differential air valve is such that the equalization of the pressure in the pipes, shuts off communication between the main reservoir and the engineer's brake valve.

The valves *Ra-Rm, Qa-Qm* are for speed control only and are actuated by the governor *U*. The valve *Ra-Rm* is to prevent the maximum allowable speed being exceeded. The centrifugal governor pulls the valve stem to the right, opening pipe *T* to the atmosphere, making a reduction of pressure in the engineer's brake valve reservoir. Valve *Rm* connects pipes *S*, cutting off connection between the main reservoir and the train line. This valve is controlled entirely by the speed of the locomotive.

The valve *Ka-Km* is controlled by the cam *D*, as shown. The air passage at the left *Ka* opens into the atmosphere through the reducing valve *L*, thus connecting the engineer's brake valve reservoir and the atmosphere, through the pipe *T*. The opening at the right *Km* connects the two pipes *S* and disconnects the main reservoir.

A similarity between the action of the valves *Ra-Rm* and *Ka-Km* is obvious. The former is controlled by the rate of speed and the latter by the distance of travel of the locomotive, and each one is independent of the other. While the other two valves have functions similar to those just described, they differ in this important respect—the application of the air brakes requires the co-operative functioning of both valves. Valve *Qa-Qm* is operated by the centrifugal governor, moving at lower speed than when it operates *Ra-Rm*. Valve *Pa-Pm* is operated by the distance of travel of the train but by a shorter distance than is required for *Ka-Km*. When the centrifugal governor has caused the ports of *Qa-Qm* to open, connection is made with the corresponding ports of *Pa-Pm*. If the ports of this valve are closed there is no resultant action on the brake. Valve *Pa-Pm* through the motion of cam *C* is open after the train has traversed the prescribed distance. The opening of the passage *Pa* of this valve connects the atmosphere, through the reducing valve *N*, to *Qa*. Consequently, it requires the co-operative action of these two valves to open up a continuous passage between pipe *T* and the atmosphere. *Pm* opens a passageway between the pipes *S* only when *Qm* is open.

The lower valve is entirely independent of all the other valves and has for its sole function the prevention of excessive speed. The upper valve is entirely independent of all other valves and when operated produces an absolute stop. The co-operating action of the other two valves permits a train to proceed, but at restricted speed.

Valves *Pa-Pm* and *Ka-Km* having been opened, there are no mechanical means for restoring them to their normal position. This is accomplished through the energization of the electromagnets *M* and *O*. Magnet *M* restores to its normal position the valve which has brought the train to a stop, but such a full stop will not occur if the engineer has been alert; and the key for closing this circuit is placed where he must descend to the ground to operate it. In the solenoid controlling the other valve, conditions are different; *O* may be energized from the inside of the cab. In addition, this latter magnet is always operated automatically whenever relay *I* is energized from the roadway.

Electrification Project Disapproved by Canadian Commission

A plan involving an expenditure of about $45,000,000 for the purpose of establishing a system of radial electric lines extending in several directions from Toronto has been investigated and disapproved by the Commission Appointed To Inquire Into Hydro-Electric Railways. The majority report opposing the plan as presented is signed by four commissioners while the minority report approving it is signed by one.

The railroads included in the proposal are spoken of as the Hydro Radials and include a total of 325 miles of line. This total is divided among five radial lines varying in length from 44 to 83 miles in length, including one line which runs from Toronto to Niagara Falls. A part of these lines are to be built while some are already in existence, owned by private corporations or owned by the Dominion government, and operated by the Canadian National Railways. Agreements are to be made for the interchange of freight and for operating over the tracks of other railroads at certain points.

Outstanding Features of the Proposed Project

The Hydro Radials, as proposed in the plan are to be constructed and operated under co-operative public ownership. Power is to be obtained from Niagara Falls and from other hydro-electric plants in the vicinity.

The type of electric railway proposed is a counterpart of a high-class steam road operating between large cities. It is proposed to combine both the interurban passenger business with the shorter suburban and in some instances local city services all for passenger transportation, together with freight business doing heavy carload service along with the lighter l. c. l. business, and express service. These additional classes are proposed to be superimposed upon an interurban railway, thus loading it to a capacity limited only by the practical operating conditions of its various lines.

The area proposed to be served by the projected system is not only the most populous in Ontario, but to some extent surrounds and is tributary to the capital city, with its population of over half a million. There have been no recent developments of suburban service by the steam roads in Toronto, and this has doubtless had a strong influence towards encouraging the project of Hydro Radials.

Findings of the Commission

The commission was appointed under Order-in-Council and was directed to inquire into and report on the whole

question of hydro-electric railways and all matters which, in the opinion of the commissioners were relevant thereto. It was also directed to make such suggestions and recommendations as might be deemed desirable.

Various matters having a bearing on the subject were raised and discussed and the findings of the commission, as published in the majority report, are as follows:

(1) "The financial condition of electric railways in Ontario and the United States in and prior to 1920 has been so precarious and unsatisfactory, and the outlook for improvement so dubious and discouraging, that the construction of the proposed system of electric railways should not, in our judgment, be entered upon unless the evidence of competent operating experts fully justified the conclusion that they will be self-supporting.

(2) "Upon full consideration of the evidence, and the proper weight to be given to the witness, we are of opinion that the proposed electric railways would not be self-supporting.

(3) "We are further of opinion that the construction of the proposed electric railways paralleling and competing as they would with the Canadian National Railway System, would be unwise and economically unsound, and would strike a serious blow at the success of government ownership.

(4) "We are further of opinion that until the Chippawa Power scheme, now estimated to cost $60,000,000 or upwards is completed, and has been in operation for sufficient length of time to be self-supporting, the Province would not be justified in endorsing the construction of an electric railway system at an initial estimated cost of $45,000,000.

(5) "We are further of opinion that the endorsement by the Province of bonds of the Hydro Electric Power Commission for systems of electric railways in various parts of the Province, at the instance of the municipalities concerned, is highly dangerous and may lead the Province into great financial difficulties. The endorsement for one locality would give rise to demands for the like accommodation for other localities, which it will be hard for any Government to refuse, and might result in the Province being drawn into serious financial liabilities, and we would therefore suggest that Government endorsement of such bonds should be discontinued. To the risk involved in accommodation endorsements, it is no answer to say that they are mere matters of form involving no real liability. Individual and corporate experience is to the contrary.

(6) "Further, we are of opinion that the expenditure of $25,000,000 on improvement of public highways in the Province having been begun, it would be unwise to commence the construction of the electric railways in question until the effect in the improvement of these highways has been ascertained, and the use of them by motor cars and motor trucks (whose competition with electric railways has been found so keen and difficult to meet elsewhere) made clearly apparent.

(7) "We are further of opinion that the rapidly increasing debts and financial commitments of the Dominion, Province and Municipalities have aroused well-founded apprehension in the minds of thoughtful citizens, and are a cogent reason against the embarkation at this time in the construction of the contemplated electric railways."

The opinion is also expressed by the railway commission that the Hydro Electric Power Commission of Ontario made a fundamental error when preparing the original estimates which was repeated when the supplementary estimates were prepared, in not seeking and securing the assistance of experienced operating men, particularly insofar as operating costs and possible revenues were concerned.

Alternative Suggestions

Near the terminations of the inquiry the commission arrived at the conclusion that as the plan was not practicable as a whole, alternatives should be presented. The conclusion was also drawn that taken separately, the most promising divisions of the system are not as likely to be self-supporting as the whole.

As the situation in the City of Toronto naturally separated itself from the rest of the project out in the province, the commission deemed that it should be treated as a purely local problem and worked out with the view that the City of Toronto should undertake the construction and operation as a municipal enterprise co-ordinated with other undertakings of a similar nature now in hand. This alternative suggestion crystallizes into a purely radial scheme based on Toronto. The term "radial," which was applied to the Hydro Radial Railway Project, had its inception in Toronto, where it is particularly applicable and from which point it appears to have grown outward from its center.

The commission states that in general such a Toronto Radial Scheme, as it might be worked out, appears to offer various advantages. It would, states the report, supply an opportunity for a truly "radial" system of railways operating into the city from a suburban belt up to say 10 or 15 miles radius. Such a unified transportation system, according to the report, would enable the Civic Commission to work out its own plans in conjunction with the problem of the street railway proper when taken over, and would not put it in the position of being a competitor with another transportation system operating within its area, such as the Hydro Radials might easily prove to be.

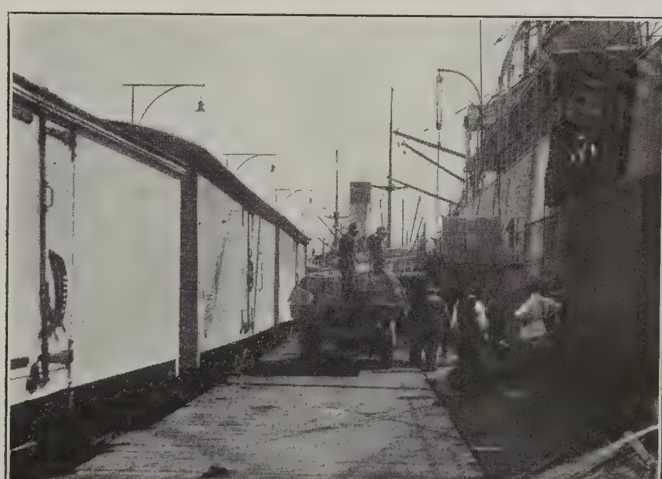
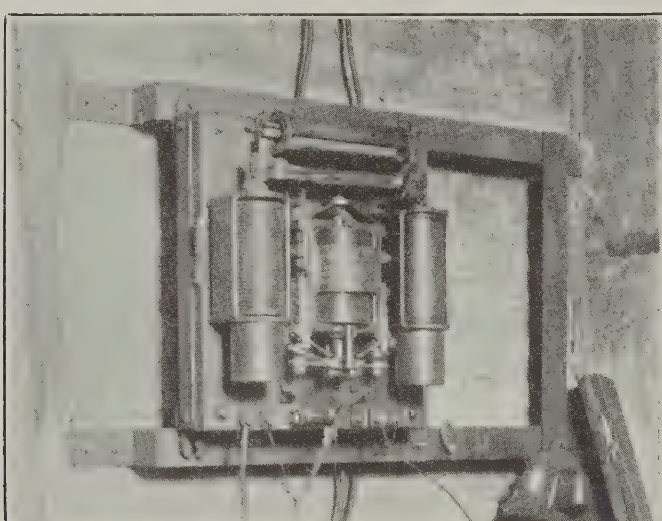


Photo by Keystone

Loading Butter for London from Car to Ship at Brisbane, Australia

Emergency Device to Increase Charging Rate

Considerable difficulty was had in maintaining the charge on a battery used in the car lighting equipment on a car operating between Chicago and Indianapolis, the run being only five hours with several hours of drain on the battery at terminals. The generator had a capacity of 75 amp. but the regulator panel was limited to 40 amp. The voltage adjustment was regulated to cut the automatic switch in at 36 volts, but this failed to cure the trouble and the battery required frequent charging at the terminal. After considerable testing the electricians



The Small Iron Wire Coil Is Paralleled With the Current Coil

in charge of the Chicago & Western Indiana coach yard at Chicago designed a coil of No. 10 galvanized iron wire 52 in. long that was placed as a shunt across the current coil of the regulator. This coil takes 20 amp. and the regular current coil takes the usual 40 amp. Therefore, it is now possible to charge the battery at from 60 to 65 amps. As shown in the illustration this coil of galvanized iron wire is mounted to the left of the current coil with the terminal ends extending behind the current coil to the terminals. A piece of fibre is placed between the coils to prevent any trouble from shorts.

"Electric-light plants are said to grow from bulbs," remarks Life. Again the old question, Which comes first, the hen or the egg?

Do not be afraid of criticism—criticize yourself often.

The Man Who Delivers the Goods

THERE'S a man in the world who is never turned down,
  Wherever he chances to stray;
He gets the glad hand in the populous town,
  Or out where the farmers make hay.
He's greeted with pleasure on deserts of sand,
  And deep in the aisles of the woods;
Wherever he goes, there's a welcoming hand—he's
  The man who delivers the goods.

The failures of life sit around and complain
  The gods haven't treated them white;
They've lost their umbrellas whenever there's rain,
  And they haven't their lanterns at night.
Men tire of failures who fill with their sighs
  The air of their own neighborhoods;
There's a man who is greeted with lovelighted eyes—he's
  The man who delivers the goods.

One fellow is lazy and watches the clock,
  And waits for the whistle to blow;
And one has a hammer with which he will knock,
  And one tells a story of woe,
And one, if requested to travel a mile,
  Will measure the perches and roods;
But one does his stunt with a whistle and smile—he's
  The man who delivers the goods.

One man is afraid that he'll labor too hard,
  The world isn't yearning for such;
And one man is ever alert—on his guard—
  Lest he put in a minute too much;
One has a grouch on, a temper that's bad,
  And one is a creature of moods;
So it's me for the joyous and rollicking lad—for
  The man who delivers the goods.

Why George Gets $500 a Month

Three brothers left the farm to work in the city and all got jobs in the same company, starting out at the same pay.

Six years later one was receiving $100 a month, a second $200 and the third $500.

Their father, hearing of these salaries, decided to visit his sons' employer and find out why they were paid on what seemed to be such an unfair basis.

"I will let them explain for themselves," said the boss, as he pressed a button under his desk.

Jim, the lowest paid man of the three, answered.

"I understand the *Oceanic* has just docked," said the employer. "Please go down there and get an inventory of her cargo."

Three minutes later Jim was back in the office.

"She carries a cargo of 2,000 seal skins," reported Jim. "I got the information from the first mate over the telephone."

"Thank you, Jim," said the boss. "That will be all."

He pressed the button again and Frank, the $200 man, reported.

"Frank, I wish you would go down to the dock and get an inventory of the *Oceanic's* cargo."

An hour later Frank was back with a list showing that the *Oceanic* not only carried 2,000 seal skins, but that she also had 500 beaver and 1,100 mink pelts.

The employer pressed the button a third time and George, the $500 man, walked into the office.

He was given the same instructions his brothers had received.

George did not return for three hours and the office had closed for the day, but his father and the boss were waiting for him.

"The *Oceanic* carries 2,000 seal skins," he began. "They are offered at $5 each, so I took a two-day option on them, and I have wired a prospect, offering them to him at $7. I expect to have his order to-morrow. I also found 500 beaver, which I sold over the telephone at a profit of $700. The mink pelts are of poor quality, so I didn't try to do anything with them."

"That's fine, George," said the boss.

Then when he had gone the employer turned to the father.

"You probably noticed," he said:

"Jim doesn't do as he is told;

"Frank does as he's told, and

"George does without being told."

—*W. S. Tyler Company Employes' Magazine.*

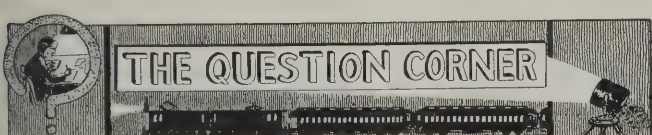
We were born and we die and don't have anything to say about either. But between coming on this earth and going, it's our own game. Lots of us make fool moves and then kick at the man who studied the game.

Who wins? The man who reads.

Views of His Own

Vendor to Railroad Passenger: "Here are some fine postcard views taken along our railroad. Would you like some of them?"

Passenger: "I should say not! I have my own views about this railroad."—*Ex.*



Answers to Last Month's Questions

1. *Assume a battery or other direct current source, whose open circuit voltage measured with a voltmeter of very high resistance is* 10 *volts, and further suppose that when this same source is short circuited through an ammeter having negligible resistance the current is* 10 *amperes. The problem is, what is the maximum number of watts this battery can supply to an external circuit, and what is the resistance of that circuit?—W. L. B.*

* * *

The foregoing problem must have caused dismay among our readers. At all events no one seemed to have courage enough to attack it. However, it is one of those problems which appear more difficult than they really are. The chief requirement for its solution is a thorough knowledge of Ohm's law.

The author of the problem gives the following solution:

Let E = open circuit voltage of generator (given)
r = internal resistance of generator
C = short circuit current of generator (given)
R = external resistance of circuit that will permit maximum watts output of generator
W = external watts to be a maximum
i = current to give maximum watts in external circuit
e = voltage on external circuit to give maximum watts therein.

Then $C = \dfrac{E}{r + o} = \dfrac{E}{r}$ = short circuit current

and $r = \dfrac{E}{C}$ = internal resistance

Now R must equal r to make W a maximum

$R = r = \dfrac{E}{C}$ = external resistance.

$$i = \frac{E}{r + R} = \frac{E}{\dfrac{2E}{C}} = \frac{CE}{2E} = \frac{C}{2}$$

$$e = iR = \frac{C}{2} \times \frac{E}{C} = \frac{E}{2}$$

$$W = ei = \frac{C}{2} \times \frac{E}{2} = \frac{CE}{4}$$

That is, the maximum watts that may be delivered to an external circuit by a direct current generator, is equal to one quarter of the product of its open circuit voltage and short circuit current.

In the problem $E = 10$ $C = 10$, hence $W = \dfrac{10 \times 10}{4} =$ 25 watts.

$$R = r = \frac{E}{C} = \frac{10}{10} = 1 \text{ ohm}$$

$$i = \frac{10}{2} = 5 \text{ amperes}$$

* * *

Questions for February

1.—*What is the difference between one ampere hour and one watt hour?*

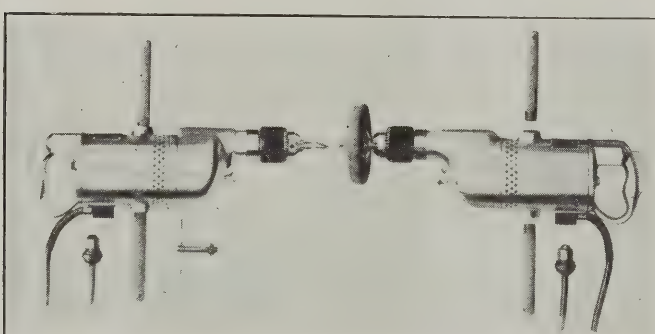
2.—*In a text book that I have, it is stated that connecting cells in series increase the current output, yet with gravity cells connected in series the current output is limited by the internal resistance to ¼ ampere. This does not seem to be an increase over the current of the individual cell. Does not the increased internal resistance of the cells in series neutralize the increase in current which might be available?* P. R. T.

NEW DEVICES

Portable Electric Drill and Grinder

A combination portable electric drill and grinder has been developed by the Wodack Electric Corporation, 27 South Jefferson street, Chicago, Ill., which is similar to the electric grinder manufactured by this company and which has previously been described in these pages. The new tool is designed particularly for use in those shops and factories where hand drilling and grinding operations are performed, but not in sufficient quantity to warrant the purchase of two separate machines.

The tool can be used for drilling metal or wood, and when used with the grinding wheel attachment will cover the average requirements for grinding. It can be used for drilling holes up to 5/8 in. in diameter in steel and



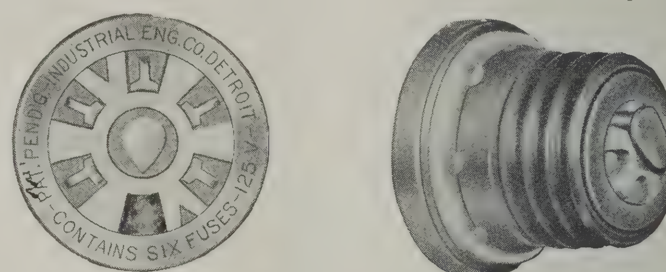
An Electric Tool That Can be Used Either as a Drill or a Grinder

when used as a grinder carries a 6 in. by 3/4 in. grinding wheel. Two separate speeds are provided, the low speed for drilling and the high speed for grinding. The weight of the tool is 18 lb. and the motor will develop 1/2 hp.

The control switch is located in the handle and is of the quick-make-and-break, automatic stop type. Aluminum castings and ball bearings are used throughout. The motor is of the universal type and can be operated on either direct or alternating current of the same voltage.

A Multiple Fuse Plug

A multiple fuse plug which combines six fuses in one and which indicates which fuse is blown has been placed on the market by the Industrial Engineering Company, Detroit, Mich. The pointer in the center of the dial, which is connected to a brass contact at the back of the plug, indicates at a glance whether the trouble is due to the fuse. If dead, the fuse section will be blackened; if live, the fuse wire can be seen. In order to change the fuse, it is only necessary to



End and Side View of Multiple Fuse Plug Which Combines Six Fuses in One

pull out the brass connector, turn it to the right or left until the pointer indicates a clear fuse.

Pulley Socket Reflector

A device for lowering lighting reflectors, known as the Cutter-Pulley-Socket-Reflector, has been developed by the Westinghouse Electric & Manufacturing Company. The

A Pull of the Chain Disconnects the Fixture and Allows Lowering Without Live Contacts

purpose of the device is to save time in cleaning lamps and reflectors, to provide safety from short circuits and accidental contacts with live parts and to do away with the use of ladders for cleaning and relamping.

A pull on the rope completely disconnects the principal parts from the live conductors and the fixture may then be lowered. It is not necessary to switch off the circuit as sliding contacts are provided in the socket which have a sufficient capacity to break the current taken by a 1,000-watt lamp. The next pull resets the fixture in place. An angle reflector may be used, as the fixture always comes back to the same position when pulled up into the socket and then locks into place so that it is self-supporting.

All parts are strongly built and enclosed in a cast iron housing which is galvanized and painted. The socket is provided with a double lamp switch, under which the lamp is held so that it cannot be loosened by vibration.

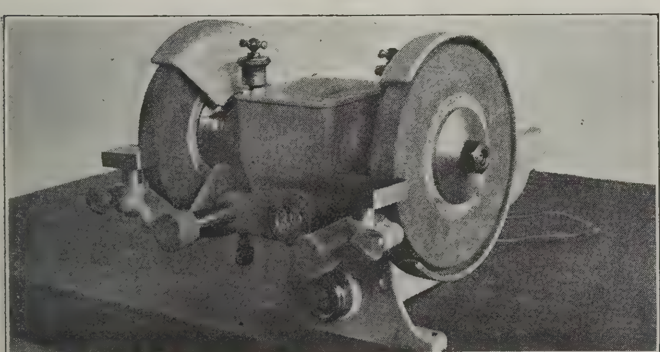
Oil Transmission Gear for Electric Traction Work

The Lenz system of oil transmission, which has been in use for some years for small powers, such as automobiles and caterpillar tractors, has been developed for experimental work in electric traction service. The new gear is suitable for transmitting from 200 to 300 brake horsepower and will be experimented with on the Prussian railways for the purpose of agitating the possibilities of this form of drive for electric locomotives.

The gear consists essentially of a pump and rotor with axes at right angles to each other, mounted in a common housing. The pump is of the multi-stage rotary shutter type, and the force of the oil stream and the consequent rate of power and speed transmitted is determined by the introduction of one or more stages or a combination of stages. The electric locomotive which is to be equipped with the gear will be placed in mountain railway service early this year and will have a running program amounting to about 62,000 miles a year. The pump will be driven by a single phase induction motor which has characteristics closely resembling those of a Diesel engine. This type of motor was chosen for driving the pump so that useful information may be obtained regarding the probable performance of a Diesel engine driven locomotive using the same gear.

Eight-Inch Electric Bench Grinder

The Black & Decker Mfg. Company, Baltimore, Md., announces a new model grinder known as the Eight-Inch Electric Bench Grinder. This is a substantial two-wheel



Black & Decker 8-In. Bench Grinder

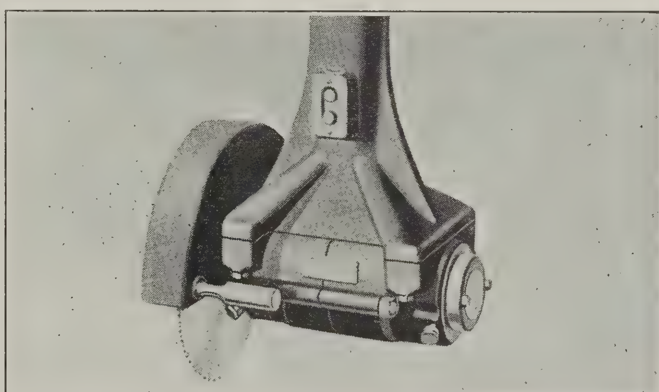
grinder, driven by a ¾-h.p. motor of the universal type similar to motors used in Black & Decker portable electric drills. It operates on alternating or direct current at will. Among the interesting features of this new model is the arrangement of the grinding wheels, which are set well forward of the motor casing and arranged so that they overhang the bench. This makes it possible to grind long pieces and odd shapes with unusual facility and also makes it possible to wear the grinding wheels down to the clamp washers, thus avoiding wheel wastage.

The motor is air-cooled and arranged so that the air intake is located 12 in. from the grinding wheels in order to reduce the possibility of grit being drawn into the machine. The machine is grease lubricated throughout.

The grinder is furnished complete with two grinding wheels, one coarse and one fine, 8 in, in diameter and ¾ in. wide; two wheel guards, two adjustable tool rests, an electric cable fitted with attachment plug and switch. A grinder of this type is particularly adapted to use in machine shops, and when installed at convenient locations on the benches will undoubtedly save many steps and a large amount of time formerly spent going to grinders located at a distance.

Motor Head for Swing Cut-Off Saw

A new motor head has been developed for the swing cut-off saw made by the Oliver Machinery Company, Grand Rapids, Mich. The swinging frame of this saw is of the usual Oliver construction, it being made in a cored form with a single arm which is centrally located. This arm is made in three standard lengths, namely 5 ft. 5 in., 7 ft. 5 in., and 9 ft. 5 in. The saw arbor, shown in



Motor Head Construction of Oliver Motor-on-Arbor Cut-off Saw Swing

the illustration, is made of crucible steel and machine ground to an accurate size.

Two types of electric drive can be furnished if desired, either belted motor drive or the motor-on-arbor type, illustrated. The belted motor drive consists of mounting a 5-hp., 1800 r. p. m. motor on a bracket in the yoke of the machine in place of the countershaft, and belting down to the saw arbor. The motor-on-arbor can be furnished only for two or three phase, 60 cycle, 220 or 440 volt a.c. and consists of a 3-hp., 3600 r. p. m. shaftless motor built in directly on the saw arbor, fitted with ball bearings and a 16-in. diameter saw with guard in handle. This motor-on-arbor drive is said to be extremely efficient, dependable, and safe, requiring a minimum of care. The motor is stopped and started by means of two push buttons on the arbor. The entire construction is rugged and the saw can be used effectively with the swing cutoff saw table manufactured by this company.

General News Section

The Erie Railroad plans to rebuild the four piers along the Hudson river at Weehawken, N. J., which were recently destroyed by fire. It is estimated their construction will cost $1,500,000.

The Interstate Commerce Commission has extended the date on or before which railroad returns showing any excess earnings above 6 per cent on the value for the period ending December 31, 1920, shall be filed, from February 1 to April 1. Representations were made to the commission that the time fixed in the order of January 16 for the filing of returns was not sufficient.

The car shops of the Erie Railroad at Buffalo, N. Y., have been leased to the Seminole Construction Company, and the new management began operations on Monday, February 6.

The shops of this road at Jersey City, N. J., have been leased to the Wagner Construction Company, the new arrangement taking effect on February 12. This contract includes also the shops at North Paterson, N. J.

The Westinghouse Electric & Manufacturing Company announces that T. H. Hays has been appointed manager of the Indianapolis, Indiana, office. Until further notice, A. E. Hitchner, assistant to the manager, industrial department, in general charge of the mining and electrochemical industries, will have general charge of the sections, formerly handled by W. H. Patterson, who recently resigned to accept the position of vice president of the Kaestner & Hecht Company, Chicago, elevator manufacturers.

A preliminary compilation of railway revenues and expenses for December for 163 roads gives a net operating income of $39,555,000 as compared with $3,930,000 for December, 1920. For these roads the revenues decreased 23 per cent but the expenses show a decrease of 31.2 per cent. The December returns have been difficult to estimate. A smaller number of roads showed a greater net operating income than is shown for 163 companies but many of the reports received later showed deficits.

The Italian ministry of public works has approved the electrification of the Bologna-Venice-Monfalcone line and the work is to be given to private industry. The Italian State Railway Administration is at present considering the question of using termo-electric centers instead of hydro-electric centers, since the latter presents the difficulty of high cost of labor and materials and owing to the shortage of water supply with which Italy is at present confronted. It is reported that the electrification of the Chiasso-Bellinzona and Arth-Goldan-Luccona lines will be completed by the end of January, 1922.

The Electric Storage Battery Co. announces the consolidation of its various New York offices. That part of the sales force formerly located at the Exide Factory Branch, 64th street and West End avenue, has been moved to the New Yoirk Branch Office at 23–31 West 43rd street, which will hereafter be the headquarters also of the export sales department. Under the new arrangement, F. L. Kellogg, manager of the North Atlantic district, embracing the New York, Boston and Rochester Branch territories; F. F. Sampson, New York Branch manager, and J. F. Kelly, Jr., export sales manager, will be located at the West 43rd street offices. The above change was made effective February 1.

A request for an increase in the rates of pay for men in signal towers—train directors and levermen—to restore differentials previously existing between those positions and the positions of dispatchers and signal maintainers, respectively, was raised by the Order of Railroad Telegraphers in a protest against the Terminal Railroad Association of St. Louis. Previous to Federal control, train directors received a higher rate than train dispatchers. The application of the various orders issued by the United States Railroad Administration affecting the classes of employees involved in this dispute has resulted in train dispatchers now receiving a higher rate of pay than the train directors, while levermen, who previously received a higher rate than signal maintainers, are now receiving less. The Labor Board denied the request of the employees.—Decision No. 611.

Trackless Trolley to Be Tried in Paris

According to a newspaper dispatch, the municipal authorities of Paris, France, are contemplating the introduction of railless electric traction, owing to the high cost of gasoline. It is thought that this would permit of a considerable reduction of fares.

A. R. E. E. Semi-Annual Convention

The semi-annual convention of the Association of Railway Electrical Engineers will be held in the Hotel Dennis at Atlantic City on June 19. Progress reports of the various committees will be presented at this time and there will be a general discussion of these reports for the purpose of assisting the committees in working up their final reports for presentation at the annual meeting, which is proposed to be held in Chicago in October.

Proceedings of the American Welding Society

The first monthy issue of the proceedings of the American Welding Society, dated January, 1922, has recently been published. The proceedings are 6 in. by 9 in. in

size and the first number contains 44 pages. Copies of each issue will be mailed to each paid-up member.

A regular program has been laid out for the proceedings and each issue will contain editorials, news of the various local sections, activities of the American Bureau of Welding, a list of new members, an employment service bulletin, important technical papers presented to the society, a question and answer column, technical items of interest to the society and the industry, and a bibliography of current welding literature.

Good Prospects for Electrical Exports in 1922

Optimism over the prospects for American exports of electrical equipment this year is expressed by E. D. Kilburn, vice president and general manager of the Westinghouse Electric International Company.

Mr. Kilburn declares that European, and especially German, competition in the electrical field cannot seriously affect America, and, as has been proved on a number of occasions America can compete with any nation in these lines in spite of her high labor costs. He also states that German competition need not be feared for Germany's manufacturing capacity is limited and that, when she has obtained a certain amount of electrical business, her deliveries will become uncertain and her prices will rise.

There is cause to be optimistic over the prospects for American exports of electrical equipment during 1922. The past year both Chile and Japan placed large orders for electrical material in America and there is every reason to believe that there will be an increasing amount of business of the same character. Every generator installed immediately creates a market for at least three times its capacity in smaller apparatus, such as transformers, meters, industrial motors and domestic ware. Hence the demand for electric appliances increases in a geometrical ratio and America is in a fair position to get its full share of this rapidly growing business.

"There is, however, a problem that still faces the exporter," Mr. Kilburn states. "Unless the American public, led by American financiers, becomes interested in investing money in foreign securities, American exporters are bound to be handicapped. Many European countries habitually buy large amounts of such securities each year and the money thus raised is naturally spent in the country of its origin. Great strides have been made in this direction as the numerous foreign loans floated here testify, but there is still ample room for constructive educational work on the part of bankers along these lines."

Automatic Substation Equipment

One of the largest single orders for automatic railway substation equipment placed in this country is announced by the General Electric Company for the Oregon Electric Railway. With the exception of one station in the city of Portland, automatic substations will supply power to 180 miles of track on this road.

The order comprises automatic control for seven synchronous converter substations, replacing the present manual control which has been in operation since 1912. The stations to be changed over are at Moffett, Tonquin, Pirtle, Lassen, Waconda, Cartmey and Orville. At Moffett and Tonquin there are two 500 kw. 600 volt converters connected in series giving 1,000 kw. at 1,200 volts for each. The remaining five stations have single unit 500 kw. 1,200 volt converters installed.

The Oregon Electric Railway, an interurban line owned by the Spokane, Seattle and Portland Railway, is operated at 1,200 volts direct current stepped down from a transmission line voltage of 60,000 at 33 cycles. The present rolling stock consists of 62 motor cars, 28 trailers and ten 50 to 60 ton freight locomotives. There are 154 miles of route on the system.

The Oregon Electric Railway was built in 1907 and originally operated as an independent 600 volt interurban road. The same interests operate the United Railways of Portland, the Spokane and Inland Empire Railway and the Spokane Traction Company of Spokane. In 1911 a substantial extension to the line was built and operation changed from 600 to 1,200 volts.

Electrolysis Report

The American Committee on Electrolysis has just issued its 1921 report, superseding its preliminary report of 1916. This report embodies such statements of facts and descriptions, and discussion of methods of electrolysis testing and electrolysis mitigation as the members of the committee have been able thus far to agree upon unanimously. Bion J. Arnold is chairman of the committee. The report is on sale by the American Institute of Electrical Engineers, 33 West 39th street, New York, N. Y.

Personals

Gilbert C. Lamb, formerly associated with the American Railways Company and the General Electric Company, is now in the service of the engineering department of the Condit Electrical & Manufacturing Company, South Boston, Mass.

C. L. Hancock has been appointed sales engineer of the Bridgeport Brass Company for its product, Phono-Electric wire. For the past two years Mr. Hancock has been connected with the sales department, and was recently in charge of the factory branch at Philadelphia. Mr. Hancock was in the service of the Westinghouse Electric & Manufacturing Company during the electrification of the New Haven, and later served for 12 years as assistant to the superintendent of electrical transmission on the New Haven.

W. H. Patterson, who has been associated with the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania, for the past sixteen years, has resigned to become Vice President of the Kaestner & Hecht Company, electric elevator builders, Chicago.

Mr. Patterson graduated from the electrical engineering course of Purdue University in 1905. He has been prominently identified for a number of years with the development of motors and control apparatus for application to cranes, compressors, elevators, hoists, and machine tools. Mr. Patterson is a member of the American Institute of Electrical Engineers, American Society of Heating & Ventilating Engineers, American Society of Refrigeration Engineers, Association of Railway Electrical Engineers, and the American Welding Society.

Eric A. Lof, industrial engineer and specialist of the power and mining engineering department of the General

Electric Company, was recently the recipient of a medal conferred on him by the King of Sweden, in recognition of meritorious services to the Swedish government. Mr. Lof was born in Sweden and came to this country in 1902, becoming connected with the General Electric Company at Schenectady in 1909. Last year he spent several months in Europe for the International General Electric Company, partly in connection with the extensive power transmission and railway electrification projects which are being planned by the Swedish government.

H. D. James, manager of the control engineering department of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been elected president of the Engineers' Society of Western Pennsylvania. Other officers, who were also elected at the annual meeting of the society, are Frederick Crabtree, vice president, and J. C. Hobbs and C. D. Terry, directors.

Mr. James had served as director of the society for three years and has been president for the past two years. He is a graduate of the University of Pennsylvania and is a member of the American Institute of Electrical Engineers.

One of his first duties as president was to preside over the forty-third annual banquet of the society held in Pittsburgh recently.

Selection as president of the Engineers' Society of Western Pennsylvania is considered a high honor among engineers as the society has a membership of more than 1,400. It maintains permanent headquarters in the William Penn Hotel, Pittsburgh.

Obituary

Edward S. Morrell, assistant superintendent in charge of electrical and mechanical equipment of the general office buildings of the Pennsylvania Railroad Company, Philadelphia, died on December 24, 1921. Mr. Morrell was born in Philadelphia in 1870, and had been associated with the electrical contracting and engineering business for a number of years, installing and designing lighting and power plants throughout the country. In 1904 he became assistant electrical engineer with the Pennsylvania Railroad Company, later appointed electrical engineer.

Trade Publications

When You Buy an Electric Furnace is the title of bulletin No. 302 issued by the Repel-Arc Furnace Company, Indianapolis, describing the "Repel-Arc" furnace.

The Wagner Electric Manufacturing Company, St. Louis, Mo., is distributing a number of illustrated mailing folders introducing the new Wagner polyphase motor. The new motor is being marketed under the name of Pow-R-full and the folders emphasize some of the new and important features of the design.

Jordon Bros., Inc., 74 Beekman street, New York City, has just issued a new publication illustrating and describing its line of commutator truing devices. The device described makes it possible to true commutators and slip rings without removing armatures or rollers from the machine.

Pratt & Cady Company, Inc., Hartford, Conn., has recently issued its catalogue No. 6, illustrating and describing the various valves and valve parts manufactured by the company. The catalogue is a 6-in. by 9-in. book, containing 160 pages, bound in cloth. Notable additions to lines shown in previous catalogues are four lines of Union Bonnet valves and a line of 800-lb. iron valves. The book also lists the Pratt & Cady automatic check valves which, although not new, were not shown in the company's last catalogue.

Westinghouse Turbine Generator Units are described and illustrated in Circular 1094-B, just issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. This publication contains a discussion of the reactance and impulse types of turbines, both the semi-double flow type and the multiple cylinder type. Bleeder turbines and geared turbines are described, and each part of the turbine is elaborately treated. The generator is also discussed in detail, and illustrations are given to show the latest types of construction.

Factory Lighting Designs is the name of a practical handbook on the subject of installation of lighting equipment recently issued by the National Lamp Works of the General Electric Company. The pamphlet is known as Bulletin No. 42 and contains 48 pages devoted to a discussion of the type of lamps and reflectors, location of units, mounting type and various other important factors which are essential to successful lighting. In the great number of diagrams given, practically every lighting requirement and condition has been met. The bulletin has been designed to fulfill the mission of a handbook for use by installers of lighting equipment.

Safety Switches and Panel Boards is the subject of Catalogue 12A, dated 1921-1922, which is now being distributed by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. This catalogue is illustrated with views of installations of safety switches in the shop, in the office, and in the home. It is specifically shown why Krantz safety switches are safe, and how they can be operated by anyone. Dimensions and list prices of these switches are given in detail. Some of the subjects that are discussed are the railway type safety panel boards, the safety car lighting panels, the auto-lock control panels, the dead-front and dead-rear safety switchboards, the live-front knife switches and many other devices.

The Baker R. & L. Company, Cleveland, Ohio, has published a catalogue and several bulletins on its line of electrically operated industrial tractors and trucks. Its new catalogue is a 32-page booklet illustrating and describing the details of manufacture and the operating advantages of the four and three-wheel tractors, its locomotive tractor and the several types of general utility platform trucks. The description of these several devices is accompanied by complete and detailed specifications with respect to dimensions, weights, power, etc. An interesting feature of the catalogue lies in the many illustrations given of the different types of these tractors and trucks and the variety of the material-handling service for which they are adapted. Bulletins No. 12, 13, 14 and 15 are devoted to a description of special types of the Baker trucks and to the electrical equipment for direct and alternating current.

Railway Electrical Engineer

Volume 13 MARCH, 1922 No. 3

A Train Control Committee

A recent order of the Interstate Commerce Commission asked 49 railroads why automatic train control equipment should not be used on certain sections of their lines. Not all of these roads will be required to make installations, but undoubtedly a sufficient number will be ordered to do so to give the various systems proposed a thorough try-out.

Because of the existing form of most railroad organizations it is probable that the signal department will be responsible for that part of the equipment which is located on the right-of-way, while the mechanical department will be responsible for the maintenance of the equipment on locomotives. The *Railway Electrical Engineer,* because electrical apparatus will be an important part of the various devices, will publish information on the subject from time to time, laying particular stress on the installation on the locomotive.

It is unfortunate that there are so many associations dealing with electrical subjects on the steam railroads and also that a part of the automatic train control equipment on the locomotive is mechanical or pneumatic, and a part electrical. The fact remains, however, that there is need for obtaining a fund of comparative data on all of the commercial types of equipment now on the market. The bulk of this development will concern the transfer of the signal indication on the stationary apparatus on the roadway to the moving locomotive.

There is a vital need for co-ordinating the work of the various committees in order that accurate data will be made available to all concerned. Some organization allied with the manufacture, maintenance and operation of locomotives should follow up the commercial developments and tests that are being made from time to time with particular reference to that part of the apparatus which concerns motive power equipment. Much of the equipment is electrical, and electrical men should be ready to take a hand in collecting the necessary information.

Welding Knowledge Important

Although the art of electric welding has grown rapidly during the past few years it must be admitted that there are many things concerning it, about which the average welder has little or no information of practical value. This lack of knowledge relative to a widely used process was plainly shown in a recent meeting of the New York section of the American Welding Society, when the subject of spot welding aroused a lively discussion among those present. From the various statements made it is evident that spot welding may be attempted upon certain classes of work for which it is wholly unsuited. One example of this kind was mentioned where several hundred low pressure tanks, which had been spot welded, failed. Experiences of this sort always tend to give the welding art a severe set-back. The trouble lies not so much in the process as it does in the attempt to apply the process to work for which it is unsuited. The stigma of these tank failures should not attach itself to the process, but rather to those who attempt to do the work in the wrong way.

The factors which enter into the accomplishment of a successful weld are many and varied. The work must be free from dirt, rust or burnt metal. Furthermore, the relative sizes are of importance. Annealing may also have to be considered. There are tricks in spot welding, a knowledge of which may prove to be just the difference between success and failure. One of these is the slight separation of the plates so as to produce an arc which makes a more effective weld. This, of course, is not regular practice, but is merely mentioned to show that the successful welder must be resourceful and ready to cope with conditions as he finds them.

In connection with unusual welding problems which are giving great difficulty, recourse may be had to the American Bureau of Welding which is a joint advisory Board of the American Welding Society, whose function is largely research and the collection of such information as will further advance the welding art.

Rubber Battery Jars

Many railroads are once again experimenting with the use of hard rubber battery jars for car lighting batteries. The principal reason for this renewed interest is that the manufacturers have developed jars made of an improved quality of material considerably better than that used in the making of jars ten or twelve years ago. Some of the electrical men who are now experimenting with rubber jars are a bit skeptical. They want to know how long the material in the jars will maintain the high strength which it has when it is new. They may or may not have reasons for their skepticism, but they can amply justify themselves for experimenting by looking over the results obtained on the Santa Fe. These results are summarized in an article elsewhere in this issue.

The majority of the railroads in the country abandoned the use of rubber jars a number of years ago because of

the high percentage of broken jars. These breakages were usually due either to rough handling, such as might be caused by rough handling of the cars in switching or by an emergency brake application, or they were caused by the growing of the positive plate. The Santa Fe has learned how to reduce the number of breakages caused by rough handling; with modern car lighting equipment batteries are not liable to as much overcharge as formerly and as a result positive plates do not grow and buckle nearly as much as they did in the early days of car lighting.

The principal advantages offered by the rubber jars are that they are not subject to the pitting caused by grounds, and a cell cannot become short circuited by having the plates wear through the thin hard rubber liners and come in contact with the lead tank. As a result, there are no leaks when rubber jars are used unless the jar is broken, and damage to plates by internal short circuits is minimized.

A few railroads still continue to use the rubber jars for small sized batteries, but the Santa Fe is the only road which has continued to use them extensively for 200-ampere hour or larger batteries, and it is not likely that any railroads now using lead tanks can produce figures to show that the cost of maintaining the lead lining is as low as 30 cents a month per car. There is a possibility for effecting a saving in this manner that is well worth an investigation.

Radio Telephone Development

For some time experiments have been under way, the ultimate aim of which was to perfect radio telephone communication between land stations and vessels in mid-ocean. While radio telephony has been in use to a limited extent for the past few years, it has always been necessary to utilize a specially prepared transmitting station. Such remarkable progress has been made that it is now possible to transmit a message from any ordinary telephone station, through the proper radio central, to the ships at sea.

It is this final step—the use of the regular telephone—that puts radio telephony within the grasp of the general public. It is easily conceivable that direct communication between individuals, between office and ocean going vessels, may be of utmost importance and it is more than probable that the public will not be slow to take advantage of this new development.

While this latest improvement has not been applied to through passenger trains, there is every reason to predict that it will eventually become a part of the regular equipment. The outstanding features which will bring about this condition are, first, the use of ordinary telephones; second, the simultaneous transmission and reception of speech over this apparatus; and third, the secrecy with which conversation may be carried on. The second factor is of utmost importance and is the latest improvement in radio communication. Heretofore it has been possible for speech transmission in only one direction at any given instant. That is, anyone using a radio telephone had to transmit his entire message before learning whether or not his listener understood all that was said. Such communication was far from satisfactory as everyone knows. This great obstacle has been successfully removed and it is now possible for the listener to interject any remark at any time.

As regards secrecy, it is possible to produce a system of distortion of the ether waves so that only the properly equipped receiving apparatus can make them intelligible.

These developments are very recent and their full importance has not had an opportunity to be appreciated. There is little doubt, however, of their advantages and it will not be in the least surprising to see some of the larger roads install radio telephones in their through trains as an additional convenience for the traveling public.

Letters to the Editor

Welding Couplers

CLEVELAND, Ohio.

TO THE EDITOR:

You speak of coupler welding on page 32 of your January, 1922, issue. I think there is some mistake or contradiction.

On page 52 of the A. R. A. rules, revised 1921, effective January, 1922, under the heading of autogenous welding limits and regulations, rule 1 in part says: "Cracks or fractures will not be permitted on grab irons, couplers and locks, brake staffs, spring or bolt hangers, or truck equalizers." Please explain this situation as there seems to be some mistake. M. A. C.

* * *

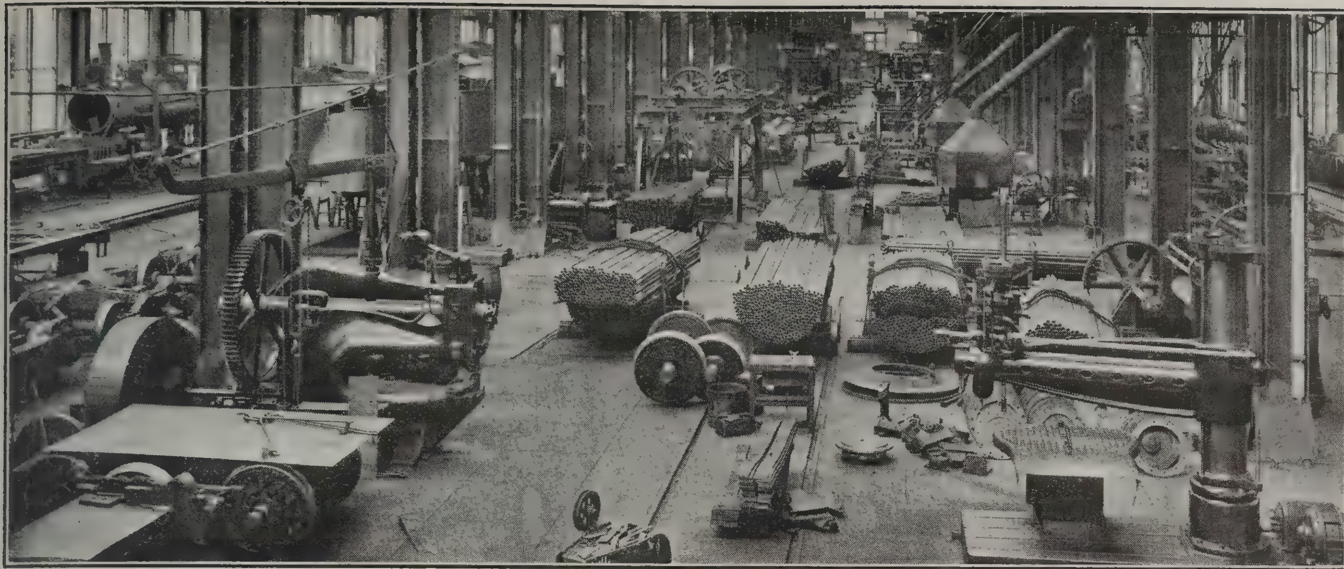
The A. R. A. rules to which you refer are, I believe, the American Railway Association's code of rules governing the condition of, and repairs to, freight and passenger cars for the interchange of traffic. Rolling stock that is to be interchanged between different railroads must comply with the rules given in this code. The rules do not necessarily apply to rolling stock not subject to interchange, and in a few such cases at least welded couplers and coupler knuckles have been used successfully.

The *Railway Electrical Engineer* does not wish to recommend practices which are not permitted by the rules in question. The item to which you refer, and which was published on page 32 of our January issue, was printed for the purpose of suggesting to the reader that it was possible to perform this class of welding successfully and that when all railroads had a better general understanding of the art of welding, some of the present rules might not be necessary.—EDITOR.

New Books

Electric Traction in the United States.—By Marcel Japiot and A. Ferrand, 612 pp., illustrated 5½ by 9 in. Paper covers. Published by Dunod, Editor, 47 Quai des Augustins, Paris, France.

The book is printed in French text. The largest portion is devoted to detail study of leading electric traction plants of large American systems. Besides descriptions as complete as possible of such equipment, the authors have attempted analyzing operation in double viewpoint of technical and economical. The work contains information heretofore unpublished, such as personal observations gathered in the course of journeys. The various systems—direct current, single phase and three phase are compared as well as the various modes of transmission used on the locomotive.



Interior View of Locomotive Shop, N. Y., N. H. & H. R. R., at Readville, Mass.

Electric Motor Drives in Railroad Shops*

Selection of Motors—Types of Motors—Application on Different Kinds of Machine Tools

By Bertram S. Pero
General Electric Company, Schenectady, N. Y.

INDIVIDUAL electric motor drive becomes practically a necessity in a railroad shop, because of the various machine tools required, and the nature of the work performed. This form of drive allows free use of overhead cranes, unrestricted location of machine tools, low maintenance, and, provided the correct electrical equipment is used, high efficiency. As an illustration of the advantages, two views of the same woodworking shop are shown in Figs. 1 and 2. These might be called "before" and "after," respectively. The transformation has really enlarged the shop and increased the possible production of each machine, because the belt slip has been eliminated.

Selection of Motors

In selecting the electrical equipment for any shop, it is well to keep in mind a few general principles. A system using alternating current motors on all constant-speed machines, with direct current for the remainder is probably the best. The second choice is direct current, because any machine tool can be successfully driven by this type of motor. If alternating current only is available, individual drive is still most desirable, even though there is no satisfactory commercial adjustable-speed alternating current motor, and gears must be used to obtain different spindle speeds.

Many machine tool manufacturers provide for speed changes through gears built as an integral part of the machine. This scheme allows a constant-speed motor to be used in many applications, but to obtain the speed increments possible with a direct-current, adjustable-speed motor would require an absurd gear combination. Very often, a single gear change is used with an adjustable speed direct-current motor to obtain a wide speed range.

The squirrel-cage and wound-rotor alternating-current motors are the two forms generally used. The squirrel-cage motor is practically a constant-speed machine, and should be used for driving machine tools producing a constant load. The wound-rotor motor is capable of exerting greater starting torque with less current than the squirrel-cage type. The so-called "high torque" squirrel-cage motor is similar in appearance to the standard constant-speed machine, the only difference being in the rotor resistance.

Common Types of Direct-Current Motors

The three types of direct-current motors generally used are the shunt, compound, and series. The series motor is not now employed as extensively as in the past. Because the compound-wound motor does not attain as high light-load speeds, it is preferable for general use. The shunt-wound direct-current motor is essentially a constant-speed machine, the slip or reduction in speed from no load to full load being about 5 per cent for the average motor. This factor is inherent in any motor, whether of the alternating- or direct-current type. The speed of any direct-current motor is governed by the rate at which the armature conductors pass through the flux set up by the field magnets. This rate is a product of armature

*Reprinted from the February, 1922, issue of *Machinery*.

conductors per unit time and flux, and is constant, under definite conditions, in any particular motor. Therefore, in a motor where the field strength is constant, the speed will be constant, and the current will increase rapidly if the load tends to lower this speed.

When the field strength is varied, as for the shunt-wound adjustable-speed motor, a speed variation is obtained, because to maintain the particular "product" or "rate" with a varying field strength, will require a change in the number of armature conductors passing through the flux, per unit time. It is obvious that the armature speed must change to accomplish this. The squirrel-cage induction motor is comparable to the shunt-wound, constant-speed, direct-current motor.

Variable-Speed and Adjustable-Speed Motors

Variable speed must not be confused with adjustable speed. So-called "variable" speed is obtained (usually with a constant-speed motor) by introducing resistance in the armature circuit. The reduced speeds obtained by this method will vary with each change of load. This is not an economical scheme, because a certain part of the power taken from the line is wasted in heat generated in the resistor. This loss is dependent on the speed reduction, being equal to

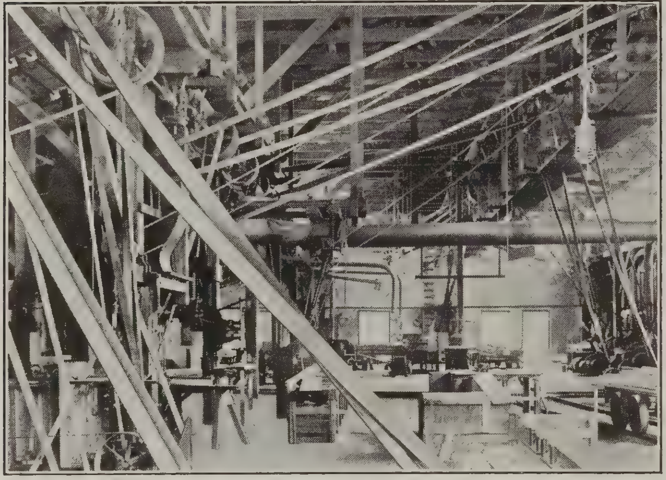


Fig. 1—View of Woodworking Shop Before Installation of Motor Drives

the output of the motor, when the speed is reduced to one-half. Besides the energy loss in the resistor, the motor output is reduced. The adjustable-speed motor uses a resistor in the shunt field circuit, and while there is a loss in this resistor, it is negligible, because the total energy input to the field is only about 3 to 4 per cent of the input to the motor; furthermore, since the field current is reduced at the higher speeds, this loss is decreased. The horsepower output of an adjustable-speed motor is constant in that the rating at high and low speeds is the same.

Compound-Wound Motors

Compound-wound motors, which have a part of the field energized by the armature current, slow down under overloads, and speed up with light loads, due to the varying field strength. This produces a motor with a higher slip than the shunt machine, which is an advantage for certain drives. The average compound-wound motor has fields of which 80 per cent is shunt, and 20 per cent series. This means that with full load there is full field, while with 25 per cent overload, the series portion becomes 0.20×1.25, or 25 per cent. This added to the 80 per cent part, which is constant, makes a total of 105 per cent, causing a speed reduction.

High-Torque Alternating-Current Motor and Wound-Rotor Type

The high-torque alternating-current motor is comparable to the compound-wound direct-current ma-

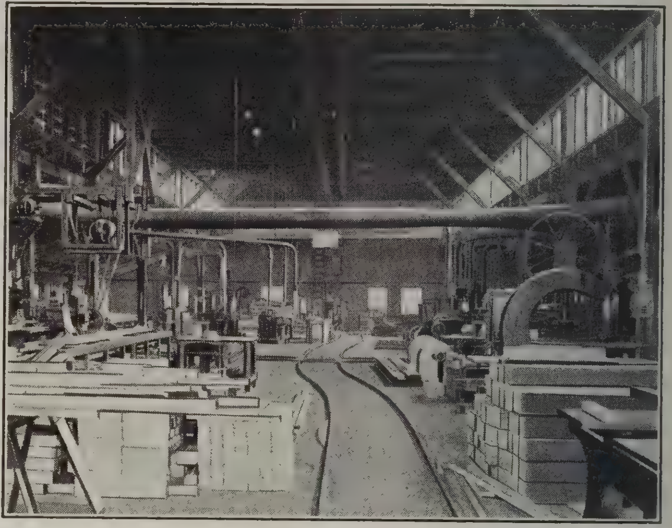


Fig. 2—Shop Illustrated in Fig. 1 After Electric Drives Were Installed

chine. This motor to all appearances is like the constant-speed squirrel-cage type, but the rotor is designed to have a greater resistance, producing greater slip at full load and higher torque at starting. When resistance is introduced in the rotor, there will be heat generated proportional to this resistance, and

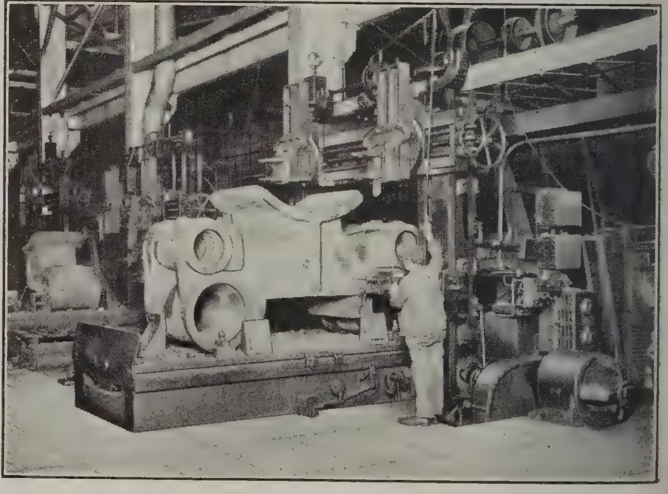


Fig. 3—Planer Driven By 25 Hp. Adjustable Speed Reversing Planer Motor

in the larger motors this heat becomes quite a factor; therefore, it is a good plan to use the wound-rotor type, connecting a permanent resistor outside the rotor, so as to obtain an equivalent slip, with the minimum heat inside the motor.

The wound-rotor or slip-ring type of motor is used for variable-speed service as required by cranes,

bending rolls, etc. It is brought up to speed by connecting the motor to the source of power and gradually short-circuiting the external resistor connected in the rotor circuit, through collector rings mounted on the rotor shaft. This type of motor is well adapted to starting heavy loads, because the torque per ampere throughout the starting period is greater than that of a squirrel-cage machine. This is because the resistance in the rotor circuit can be adjusted to produce the best torque conditions for each speed during

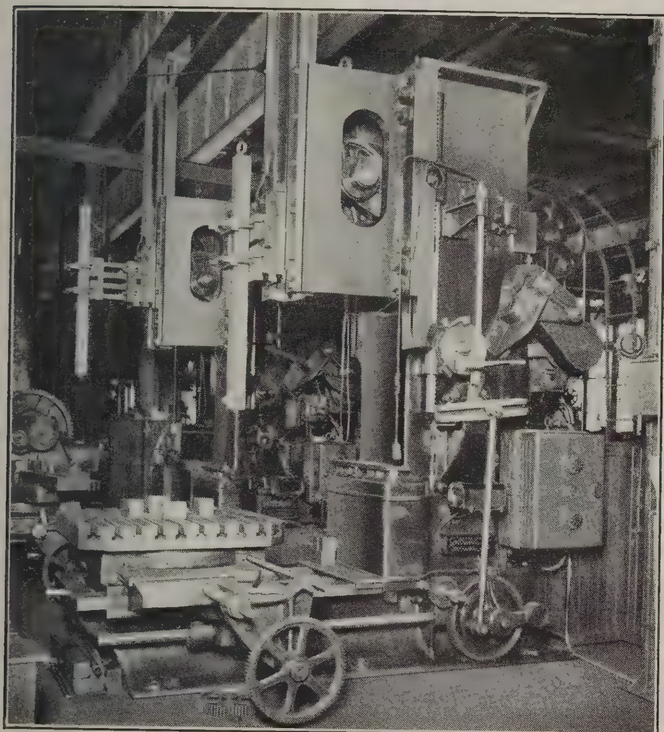


Fig. 4—Slotter Driven By 15 Hp. Adjustable Speed Reversing Planer Motor

acceleration, whereas the resistance in the squirrel-cage machine is fixed and is comparable to the wound-rotor type of motor at one speed only.

Series Motors

In the series motor, all the field is produced by armature current. It is obvious that with a very light load there is practically no field, and the armature will run at a very high speed to maintain the "product" or "rate" referred to above. Also, with a 25 per cent overload, the field will have a strength of 125 per cent instead of 105 per cent as for the compound machine, and a lower speed will result. Commercial series motors do not produce the same speeds or torques on overload that a theoretical motor would, because the iron used in the fields becomes saturated after a certain flux is produced, and any current in excess of that which will saturate the fields has practically no effect on the field strength. Because of this condition, it has been found more desirable to use a motor with 50 per cent shunt and 50 per cent series on many of the machines heretofore driven by series motor. The "50-50" motor will produce nearly the same torque per ampere, and has the advantage of a lower no-load speed. Approximately 150 per cent full load speed is obtained on light load.

Motors for Different Types of Machine Tools

In general, machine tools can be classed in two groups. The first group includes those machines that are used for the purpose of removing metal by cutting tools or abrasive, such as lathes, boring mills, grinders, etc. Practically all machines of this group produce a continuous load, requiring a constant torque for any given condition of speed and cut. These machines should be driven by shunt-wound direct-current, or squirrel-cage induction motors. Because of its freedom from sliding contacts, the squirrel-cage induction motor is desirable for driving woodworking machines; if direct-current motors are used for service of this kind, the fire hazard is increased.

The second group of machine tools includes those machines used for forming or shearing metal, such as punches, bending rolls, etc. Generally, compound-wound motors should be used for driving this class of machines. There are exceptions to this, however, as for example, rotary beveling shears and punch presses used on rapid cycle work, where the load is practically constant for a certain operation, and in such cases a shunt-wound motor can be applied.

Type of Motor for Machines Having Flywheels

In general, all machines having flywheels which deliver energy during the working period, or machines requiring high torque intermittently, or for "break away" conditions, should be driven by a compound-wound motor. The reason for this application to flywheel machines is to allow the use of a smaller motor, and therefore greater efficiency. We have shown that

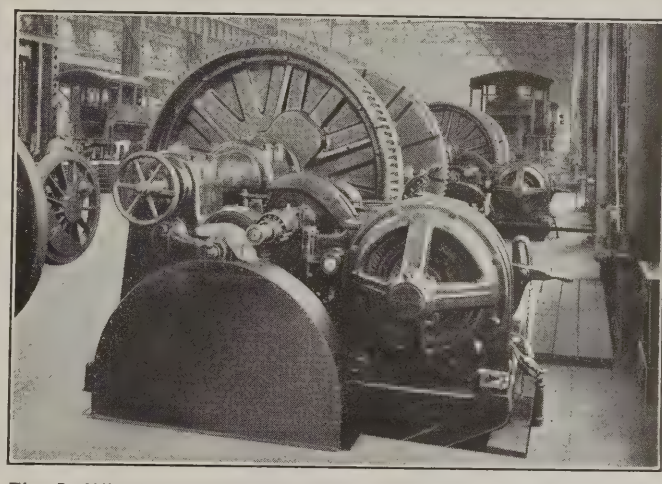


Fig. 5—Wheel Lathe Driven By 75 Hp. Wound Rotor Alternating Current Motor

the compound-wound motor has a greater slip or speed reduction, from no load to full load, than the shunt-wound motor and, since the energy delivered by a flywheel is dependent on the speed reduction, a motor with a tendency to slow down with load will allow a greater reduction in flywheel speed, without injurious overload currents on the driving motor, and enable the flywheel to furnish more energy for the work. After the work stroke is completed, and before the next stroke, the motor accelerates the flywheel, thereby restoring the energy consumed. When a motor is correctly applied, it will be delivering a non-injurious overload at the moment the work is com-

pleted. This overload decreases as the flywheel attains speed, and then the motor furnishes only the power required for windage and friction load, until the next cycle.

The loads on presses and similar machinery usually last only a very short time, and even though the power required might be high for this time, a comparatively small motor, with several seconds to replace the energy in the flywheel, would take care of the load. Obviously, when the time between strokes decreases, there will be less time to restore the energy to the flywheel and the motor must be of greater capacity, up to the point where the work strokes are so rapid that the flywheel is of very little use, the motor delivering all the energy.

When a load demands high torque for "break away," such as for large lathe carriages, cross-rails, etc., the compound-wound or series motor should be used, because, since the torque developed by a motor is a function of the field strength and armature current, and it has been shown that the field strength of a compound or series motor increases beyond 100 per cent for overload currents, the torque per ampere input is greater in these motors than in a shunt-wound machine. Series motors should never be belted, because, should the belt break and remove the load, the motor would attain dangerous speeds.

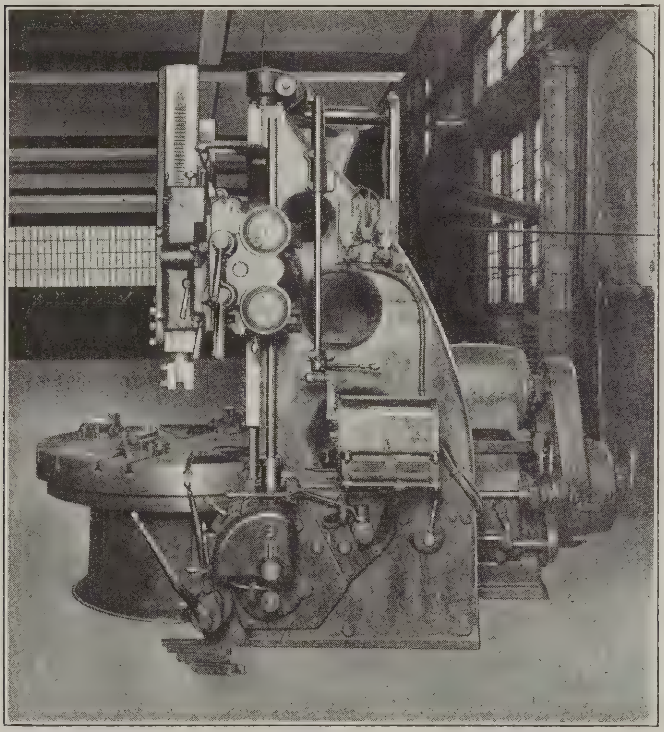


Fig. 6—Boring Mill Driven By a 15 Hp. Adjustable Speed Motor

The Type of Control

In selecting the control for any application, it is good practice to arrange to have all control, such as starting, stopping, reversing, and speed changes from one handle or station. This is especially important on machine tools where the operator should watch his work while starting, such as with lathes, boring mills, etc. The controlling station should be convenient to the operator, when he is in the most advantageous position to watch his work.

Open type control should never be used when there is any chance of chips or other foreign matter coming in contact with any other of the working parts. Automatic control is applicable to machines performing repeated cycles, such as planers, slotters, etc., or for motors driving pumps, air hammers, wheel lathes, milling machines, etc., but for engine lathes, bending rolls, or any machine tool where a set, or predetermined speed, is not applicable, manual control has been found

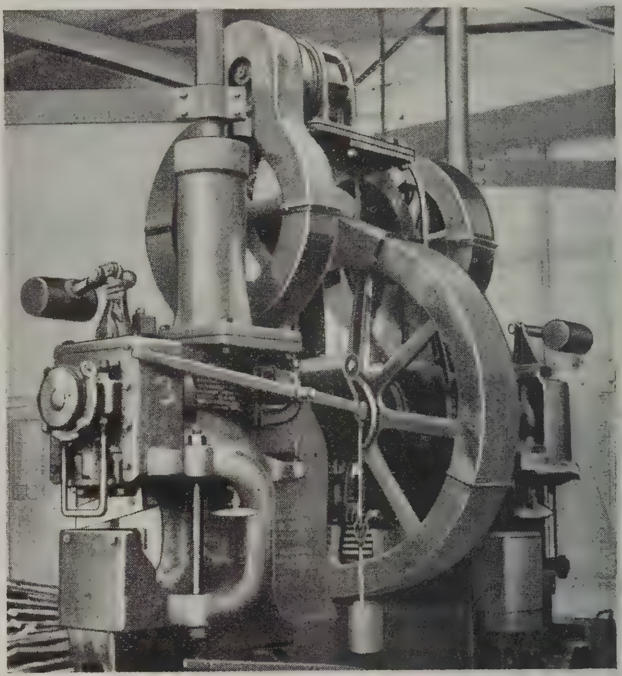


Fig. 7—Punch and Shear Driven By a 10 Hp. Alternating Current Motor

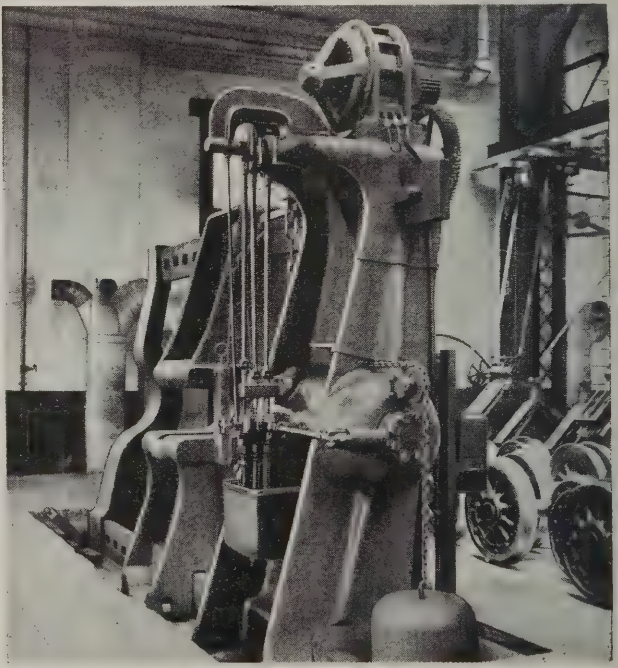


Fig. 8—A 600-Ton Wheel Press Driven By a 25 Hp. Alternating Current Motor

to answer the requirements best. A control that allows the operator to change to the most efficient operating speed without leaving his work will usually permit the greatest production to be attained.

Under-voltage protection should be provided by the control. This means that if the voltage fails, the motor will not start unexpectedly when the power returns. An equipment without this protection might easily cause an accident. Under-voltage release, which means that the motor will restart, should not be confused with under-voltage protection.

Dynamic braking, which is generally used on reversing equipments, and sometimes on non-reversing control, causes a motor to come to rest, because the motor, driven by the stored energy in the rotating parts of the machine, acts as generator, and changes the stored mechanical energy to electrical energy, which is transformed into the heat in the brake resistor.

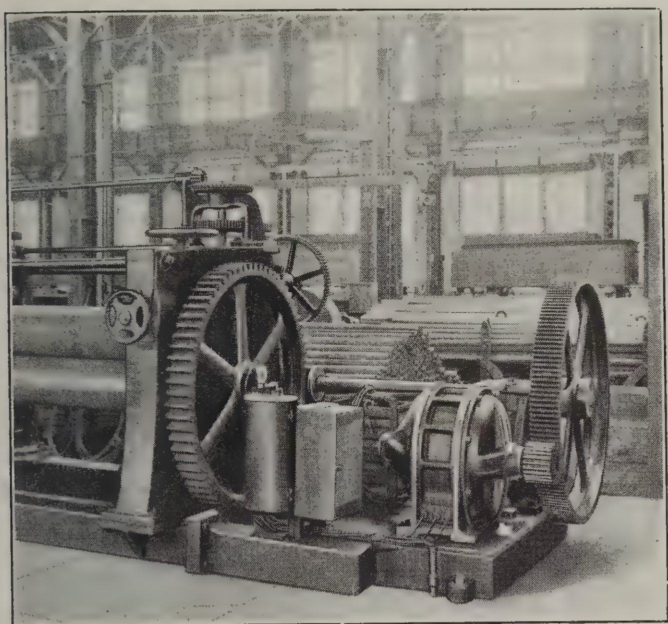


Fig. 9—Straightening Rolls Driven By a Wound Rotor Having Drum Type Control

Examples of Motor Drives for Machine Tools

The direct-current reversing planer drive shown in Fig. 3 employs an adjustable-speed motor, with a speed range of 250 to 1000 revolutions per minute. The motor is direct-connected, which thereby eliminates the losses caused by belt slip. By actual test, it has been found that with 80 per cent load on a belted planer, the slip reduced the cutting speed 12½ per cent, and with slightly over 100 per cent load, the limit of the pulling power of the belt was reached. The control for the reversing equipment starts, stops, and reverses the motor in the shortest practicable time, and allows independent adjustment of either the cutting or return speeds. The cutting speed range is from 250 to 500 revolutions per minute, and the return speed, 500 to 1000. The same equipment is applicable to rack and screw driven slotters. The slotter shown in Fig. 4 is driven by a 15-horsepower reversing planer motor having a speed range of 250 to 1000 revolutions per minute.

The electrical equipment on the wheel lathes shown in Fig. 5 provides automatic acceleration and manual slow-down when hard spots are encountered. With the direct-current equipment, an adjustable-speed motor is used. It is possible to set the speed at some value within the range, and the control will cause the motor to accelerate to this predetermined speed each time. By means of a portable push-button, the operator can slow down the motor to at least 50 per cent speed, when the tool approaches the hard spot. After this is past, releasing the button allows the motor to accelerate to the set speed. When the stop-button is depressed the motor is brought to a quick stop by dynamic braking. A switch is mounted on the panel for emergency reversing.

Fig. 6 shows a motor-driven boring mill equipped with a drum controller and a 15-horsepower motor, having a speed range of from 550 to 1650 revolutions per minute. Boring mills of the larger sizes are generally provided with magnetic control. The punch and shear shown in Fig. 7 and the wheel press shown in Fig. 8, are driven by continuous-running, alternating-current motors, while the straightening rolls, Fig. 9, are driven by a wound-rotor motor with drum type control. The guide grinder illustrated in Fig. 10 is driven by a 10-horsepower induction motor. The methods of mounting these motors and the general arrangement of the transmission of power from motor to machine are clearly illustrated. With the installation of new equipment in railroad shops, more electric drives may be expected.

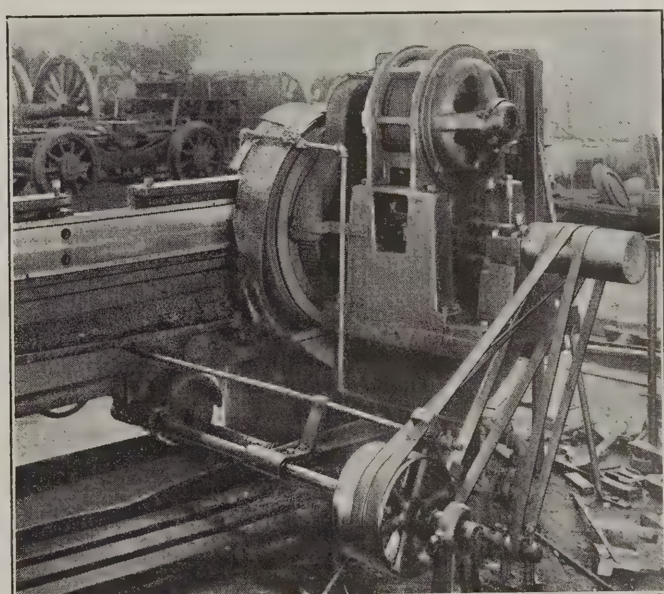


Fig. 10—Guide Grinder Driven By 10 Hp. Induction Motor

Motor buses are being operated by highly organized methods in England. There are 5,000 omnibuses in regular operation, carrying 25 to 30 persons with an average speed of 20 miles per hour. They make 14-day trips through Wales at a charge of $112. They are now taking passengers from London to the Scottish Highlands, a 17-day trip, with the best hotel service, for a fare of $150.

Increasing Welding Speed

By H. R. Pennington

Supervisor Electrical Equipment and Welding, Chicago, Rock Island & Pacific

One of the most important questions facing the advocates of fusion welding is that of finding methods of increasing the speed of arc welding. Welding speed on a given section is fundamentally dependent upon the rate of metal deposition and the amount of metal required to complete the weld. The first factor—rate of metal deposition —varies with the energy required to liquefy the electrode material, arc stability, current density, etc. The amount of metal which must be applied obviously depends upon the type of joint and opening necessary to effect fusion between the edges or members to be joined.

The size electrode and arc current value that can be used seem to be limited only by the thermal capacity of the base metal or joint. That is, the heat or arc current and electrode diameter can be increased until the molten metal of the weld area becomes difficult to control, or until the effect of expansion and contraction becomes an obstacle.

One of the principal obstacles encountered in the past on attempting to use large diameter electrodes, was the poor welding qualities of such materials. With ordinary large diameter bare electrodes, a violently sputtering arc, throwing out metal in all directions, is a common occurrence at arc current values exceeding 200 amperes, and at 300 amperes the disturbances render the arc control very difficult and extremely uncomfortable. No doubt one reason for this is the fact that the beneficial effect to the welding characteristic incident to drawing of electrodes in wire form are not present to the same extent in large diameter electrodes or what would commonly be classed as rods. These disturbances and poor welding characteristics of large electrodes generally resulted in inadequate penetration and nonuniform fusion.

If the electrodes are coated a quite stable arc will be secured, permitting welding with metallic arc up to 500 amperes with adequate penetration, uniform fusion and with a considerably lower electrode current density than that required for bare wire.

As a working basis for comparison, the rate of deposition for the usual size bare electrode and that of ¼-in. coated, both of mild steel grade on ½-in. plate wire, were determined with the following results:

Elec. dia.	Arc amps.	Lb. elec. consumed per hr.	Ft. per hr., single fillet lap weld	Lb. of elec. per ft. of fillet	Elec. current density
5/32 in. bare	150	2.3	6.8	0.33	7,850
¼ in. bare	300	7.7	10.4	0.74	6,220
¼ in. ccated	300	8.09	18.6	0.43	6,220

It will be noted that the increased speed of ¼-in. bare over 5/32-in. bare is not in proportion to the increased arc current. The increased pounds of electrode material per foot of fillet is due to the excessive amount of metal loss in passing through the arc.

The lower speed and rate of deposition of the ¼-in. bare as compared to ¼-in. coated is due to the difficulty of controlling a high current arc when using bare electrodes. Despite the greater amount of metal deposited, high current welding resulted in over a 100 per cent increase in speed of welding of a single fillet lap joint.

These figures were obtained under ideal conditions and could not be equaled in commercial practice, as further tests have proved. However, the relative speed between small diameter bare electrodes and large ¼-in. coated electrodes with high arc current will remain practically the same. An additional factor to consider in using large electrodes is the fact that the time required to consume a large electrode is greater than that for a small one and therefore the percentage of welding time is actually increased. This load cycle should be given consideration when determining the capacity and basis of ratings of welding units for large electrode welding.

Experiments with high currents and large electrodes with exceptional penetration qualities, indicate that the speed of butt welding can be increased by 100 per cent over present practice, especially since by using deep penetration electrodes the amount of scarfing necessary would be greatly reduced, if not eliminated, on plate thickness up to ⅜ in. A reduction in the amount of scarfing is also desirable where high arc currents are used, in order to increase the thermal capacity of the joint.

The lap joint offers greater advantages, however, for large electrode welding than the butt joint, as the lap joint possesses inherently the requisite high thermal capacity and therefore permits a high energy concentration with an attendant high rate of fusion and deposition. In addition, lap joints, with double fillet will permit the securing of 100 per cent weld strength without difficulty.

A recent check on pounds of metal consumed per hour, using ¼-in. mild steel coated electrodes with 240 amperes arc current, showed the rate of deposition to be six pounds per hour. These figures were obtained from actual shop practice on locomotive frame welding and include time for considerable cleaning.

From the foregoing it is clear that the limit of speed and rate of metal deposition has by no means been attained in present day practice, but in order to permit the use of higher arc currents, the electrical resistance of the electrodes must be decreased by an increase of electrode area. Otherwise, difficulty of arc control will be experienced, due to overheating of electrode.

Attention has been drawn to the possibilities in this direction in order that those contemplating the adoption or extension of arc welding may give consideration to high arc current welding, which from present indications will be increased to at least 300 amperes for a great majority of the work now done with arc current values not exceeding 200 amperes.

Early Days on the London & North Western

Electrical Reports at the A. E. R. A. Convention

Factors to Be Considered in the Use and Extension of Electric Power in Railway Operation

AT the twenty-third annual convention of the American Railway Engineering Association held at the Congress Hotel, Chicago, March 14-16, inclusive, the reports presented by the committee on electricity include a number of interesting ideas concerning the factors involved in the growth of electrical power in railway operation. The work of the various sub-committees embrace the following subjects: Electrical Interference; Water Power; Electrolysis; National Electric Safety Code; Overhead Transmission Line Construction; Clearances—Third Rail and Overhead; Collaborating with the Committee on Economics of Railway Location, and Standardization. The following are abstracts of the more important findings of the several sub-committees:

Electrical Interference

The committee was instructed to continue the study and report on electrical interference with telephone and telegraph lines caused by propulsion circuits, including recommendations for eliminating, as far as practicable, interference with signal and telephone and telegraph lines caused by propulsion circuits and adjacent transmission lines.

On account of the confliction of interests involved in any attempt to mitigate electrical interference troubles, it seemed advisable to secure co-operation of the committee of the T. & T. Section of the A.R.A. handling the subject of inductive interference.

It will be noted that mitigating measures listed under the three heads "A," "B" and "C" are divided into three sections: First, measures which may be employed by the communication companies, including the railroad communication interests; second, measures which may be employed jointly by the communication interests, and the power and traction interests; third, measures which may be employed by the power and traction interests.

It is recognized that electrolysis should be classed under the heading of "Electrical Interference." This matter has been handled completely by the American Committee on Electrolysis.

These various measures have been assigned to members of two committees, with a view to having worked up a text to cover simple statements of the troubles experienced, together with the method of handling these troubles. This work already is progressing satisfactorily.

The committee therefore submits, as a progress report only, the following statement, covering possible mitigating measures which may be employed, and suggests that the committee be continued with a view to presenting later a discussion of the various items as included in the statement.

In listing mitigating measures, or measures used for other purposes which might mitigate interference, the committee, at this time, makes no definite recommendations as to their practicability.

(A) Measures to minimize telephone and telegraph interference caused by alternating current propulsion distribution circuits.

SECTION I

1. Neutralizing transformers in telephone and telegraph circuits.
2. Shunts, filters and drainage coils in telephone and telegraph circuits.
3. Balance of telephone circuits.
4. Transposition of metallic circuits.
5. Insulation of telephone and telegraph circuits.
6. Adjustment of operating current of telegraph circuits.
7. Cables for telephone and telegraph circuits.
8. Carrier circuits.
9. Metallic telegraph circuits.
10. Telephone and telegraph protectors.
11. Shielding conductors.

SECTION II

12. Relative position of telephone and telegraph circuits and propulsion circuits.
13. Avoidance of common ground connections for power and communication circuits.

SECTION III

14. Frequent transformer sub-stations feeding trolleys and feeders with provision for sectionalization.
15. Avoidance of stub end feed.
16. Auto-transformers, distribution system as installed on the New York, New Haven & Hartford Railroad.
17. Track booster transformers.
18. Feeder booster transformers.
19. Return feeders.
20. Current limiting reactors.
21. High speed circuit breakers and relays for power circuits.
22. Potential neutralizing conductors.
23. Reduction of track leakage.
24. Track bonding.
25. Double trolley.

(B) Measures to minimize telephone and telegraph interference caused by direct current propulsion distribution circuits.

SECTION I

1. Balance of telephone circuits.
2. Transportation of metallic circuits.
3. Cables for telephone and telegraph circuits.
4. Carrier circuits.
5. Metallic telegraph circuits.
6. Ground potential regulator.
7. Insulation of telephone and telegraph circuits.
8. Telephone and telegraph protectors.

SECTION II

9. Relative position of telephone and telegraph circuits and propulsion circuits.

10. Avoidance of common ground connections for power and communication circuits.

SECTION III

11. Elimination of tooth ripples in generators by
    (a) Design of generators.
    (b) Use of resonant shunts.
    (c) Phase adjustment of two generators mechanically coupled.
12. High speed circuit breakers with resistance.
13. Flash suppressors.
14. Frequent sub-stations.
15. Return feeders.
16. Track bonding.
17. Reduction of track leakage.
18. Double trolley.

(C) Measures to minimize telephone and telegraph interference caused by transmission circuits for a. c. and d. c. propulsion systems and for other supply lines.

SECTION I

1. Shunts, filters and drainage coils in telephone and telegraph circuits.
2. Balance of telephone circuits.
3. Insulation of telephone and telegraph circuits.
4. Adjustment of operating current of telegraph circuits.
5. Cables for telephone and telegraph circuits.
6. Carrier circuits.
7. Metallic telegraph circuits.
8. Telephone and telegraph protectors.

SECTION II

9. Relative position of telephone and telegraph circuits and transmission circuits.
10. Co-ordinated transposition of power and telephone circuits.
11. Avoidance of common ground connections for power and communication circuits.

SECTION III

12. High speed circuit breakers and relays in power circuits.
13. Current limiting reactors and resistances.
14. Design, construction and arrangement of apparatus in high tension lines.
15. Operation and maintenance of high tension lines.

The Committee recommends that the subject be continued with the view of establishing, if possible, recommended remedial measures.

W. M. Vanderluis, Chairman; J. C. Davidson, Vice-Chairman; R. Beeuwkes, J. V. Duer, S. Withington, Sub-Committee.

Water Power

The committee was instructed to continue the subject and report on the utilization of water power for railroad electric operation, co-operating, if desirable, with the United States Geological Survey in its Super Power Survey. The report of the Super Power Survey was not available until shortly prior to the conclusion of this report and the committee therefore was not afforded opportunity to give it the comprehensive study that the importance of the subject deserves.

The following report deals specifically with sources of electric power available for the operation of railroads, within economical reach of the Niagara and St. Lawrence Rivers and tributaries of the St. Lawrence River.

(1) Niagara River

WATER AVAILABLE: The Niagara River is the outlet of Lake Erie, conducting the waters from the immense storage basin of the four upper lakes, located on a plateau above elevation 573 above sea level, into Lake Ontario, at elevation 246 above sea level. Through this river there passes an approximate average of 220,000 cubic feet of water per second. Could all of this water be utilized for the full head of 327 feet, more than seven million horsepower would be developed. However, the fall in the river between the cities of Buffalo and Niagara Falls reduces the head to about 314 feet, which includes the rapids immediately above the falls, the cataract itself and the rapids below. Out of this head at least 300 feet can be obtained as useful in power development, and with all of the water from the river being utilized would produce approximately 6,600,000 potential horsepower. The river being a boundary stream, the water is naturally divided between Canada and the United States, or, the Province of Ontario and the State of New York. Assuming the division of water between the two countries to be equal, each country would then have approximately 3,300,000 potential horsepower.

Diversion of water at Niagara Falls is now made under a treaty between Great Britain and the United States and is restricted to a total of 56,000 cubic feet per second, divided 36,000 on the Canadian and 20,000 on the American side. (Each country is entitled to 50 per cent of the waters diverted along the international boundary; the above division is governed by the amount of water taken at other points.)

Government engineers are of the opinion that water sufficient to produce approximately 2,000,000 horse-power, 800,000 at plants to discharge into the Maid-of-the-Mist Pool and 1,200,000 at plants below the lower rapids, may be diverted at Niagara; and it is not improbable that a further change may be made in the division between the aesthetic and the commercial and that in time 3,000,000 horse-power may be there developed.

There are now developed on the American side approximately 300,000 horse-power. This will be increased upon the completion of construction work now under way to 400,000 horse-power. There, therefore, remains 600,000 horse-power to be developed on the American side to equal the amount set by Government engineers at the present limit.

Transmission

Electric power is now being transmitted approximately 250 miles from Niagara Falls and tentative designs and estimates made by the Niagara Falls Power Company indicate that power could be transmitted in large quantities under present conditions to New York City for approximately one cent per kilowatt hour, including generation as well as transmission.

Stability and Continuity

The Niagara River constitutes the outflow from a very large drainage area and lake system which gives it an almost constant flow, slight fluctuations only being caused by weather conditions on Lake Erie which tend to increase or decrease the flow but temporarily. It is doubt-

ful if there exists a more constant and reliable source of energy elsewhere than that obtained by the development of the waters of Niagara River.

American Side

The present development on the American side at two plants is as follows:

Location	Effective Head Linear Ft.	Using Cu. Ft. Per Sec.	Installed Capacity H. P.	Usual Average H. P.
Niagara Plant	140	9,000	105,000	90,000
Hydraulic Plant	212	10,500	268,500	210,000
Total		19,500	373,500	300,000

These plants belong to the Niagara Falls Power Company. This company is now constructing a 32-foot tunnel to the Hydraulic Plant for the purpose of re-developing the water now going to the Niagara plant. This water will be used to drive three 70,000 horse-power units, which will add 210,000 horse-power installed capacity to the system and place Niagara plant in reserve.

The development on the American side will then be as follows:

Location	Effective Head Linear Ft.	Using Cu. Ft. Per Sec.	Installed Capacity H. P.	Usual Average H. P.
Hydraulic Plant				
Original Installation	212	11,100	268,500	210,000
Extension to Original Installation	215	8,400	210,000	190,000
Total for continuous use		19,500	478,500	400,000
Niagara Plant (hold in reserve)			105,000	
Total installed capacity			583,500	

During the hours of peak loads, the Niagara plant will be brought into commission and will also be used as a standby in case of repairs or shut-down at the Hydraulic plant.

In addition to the above plants, the Niagara Falls Power Company owns the stock of the Canadian Niagara Power Company; the plant is located on the Canadian side of the river, with an installed capacity of 112,500 horse-power and normal output of 100,000 horse-power. The combined American and Canadian plants of the Niagara Falls Power Company will, therefore, have, under present treaty conditions, the following development:

Location	Installed Capacity H. P.	Usual Average H. P.
American Side	583,500	400,000
Canadian Side	112,500	100,000
Total	696,000	500,000

Power from the Canadian side is transmitted to the American side, tied in with the current from the American plants and distributed to American industries. From the 696,000 installed capacity it is believed 100,000 horse-power would be available for railroad electrification.

The specific recommendation of the Government engineers is that the treaty be modified to allow an increased diversion of 20,000 cubic feet more water per second on the American side. This will develop 600,000 horse-power, a large part of which could be made available for railroad electrification. The enlargement of treaty permits for increased diversion of water is now being considered by both the United States and Canada.

Beyond the specific recommendation of the Government engineers is a further tentative expression of conclusions from their investigations which indicates that the final division allowance on the American side may be at least 15,000 cubic feet of water per second in excess of the specific recommendation already made. This further amount of water would add approximately 450,000 horse-power, making a possible ultimate total on the American side of 1,628,500 horse-power.

Canadian Side

In Canada there are three complete plants in operation, namely:

Location	Installed Capacity H. P.
Toronto Power Company	125,000
Ontario Power Company	200,000
Canadian Niagara Power Company	112,500
Total	437,500

The Ontario Power Company is now owned by the Hydro-Electric Power Commission. This Commission also has in the course of construction the Chippawa-Queenston Canal project, the plant for which will be located below the lower rapids. The canal is approximately fourteen miles long. Starting from the Niagara River at the mouth of the Welland River, it follows the course of the latter, for which the flow has been reversed, for a distance of five miles and thence by open cut around the city of Niagara Falls, Ontario, northerly and northeasterly to an immense forebay that is within one mile of the plateau's edge at Brock's Monument. At the foot of the cliff, immediately below this forebay and on the river's edge, the power plant will be located. In this plant nine 50,000 horse-power units are to be installed. This plant is being constructed from funds subscribed by the various municipalities located within the Province of Ontario, bonds for which are guaranteed by the Province. Each municipality will be allotted its quota according to the horse-power it requires and for which it has subscribed. Its current, therefore, like that from the Toronto Power Company, will be used for the benefit of the Canadian public.

Upon the completion of the plant at Queenston, the development on the Canadian side will be as follows:

Location	Installed Capacity H. P.
Toronto Power Company	125,000
Ontario Power Company	200,000
Queenston Plant	450,000
Total for Canadian Use	775,000
Canadian Niagara Power Co.	112,500
Total in Canada	887,500

For the above installations there are available under the present treaty 36,000 cubic feet of water per second, which is insufficient to operate the entire development at capacity. It is, therefore, reasonable to suppose that the Canadians either anticipate an increase in the permits under the treaty rights or otherwise will delay the installation of units at the Queenston plant, for which the water requirements would exceed the amount allowed; or, place in reserve the Ontario Power Company's plant.

Niagara Falls Junior

This scheme suggests a dam across the Niagara River below the lower rapids a little more than a mile below the Whirlpool where there is low land on the Canadian side between the river and the bluff called Foster Flats. It is claimed by the promoters that the dam will produce a head of 100 feet and utilize all of the water that goes over the cataract together with that returned to the Maid-of-the-Mist Pool from plants adjacent thereto. This would amount to about 180,000 cubic feet of water per second, assuming the treaty to be modified as suggested

by Government engineers, and would produce approximately 1,800,000 potential horse-power.

The mill pond if thus created would destroy the scenic effect now produced by the rapids and therefore must have the sanction of both the Governments of Canada and the United States.

(II) The St. Lawrence Waterway

In the fall of 1919 the Canadian Government accepted the invitation of the United States Government to undertake a joint investigation of the improvement to the St. Lawrence River.

The physical conditions are favorable for improvements for navigation which will be permanent and will have very low upkeep cost. For the project as recommended in the report, the total cost of improvement from Montreal to Lake Ontario is $252,728,000. This is an estimate based on present-day prices (considered to be about 80 per cent above pre-war prices) for a 25-foot depth with such provisions that a 30-foot depth may be secured later without interfering with the use of the waterway. It also includes the cost, to the switchboard, of developing 1,464,000 h.p.

Power Possibilities

Improvement of the entire reach from Montreal to Lake Ontario for navigation alone is feasible, and the development of nearly all the potential power in the river, amounting to 4,100,000 h.p., can be made as co-ordinate parts of schemes for the improvement of navigation when conditions warrant.

The simultaneous development of such a vast quantity of power is not a sound economic procedure, as a market to take this output is not now in existence, and cannot be expected to spring into being at once.

(III) Shawinigan Falls, Province of Quebec

Shawinigan Falls are located on the St. Maurice River about fifteen miles due north of that part of the St. Lawrence River, known as Lake Saint Peter. At present the combined generating capacity of this development is 300,000 h.p. With the flow of the St. Maurice River, regulated by the La Loutre Dam great storage basin, which has been constructed by the Quebec Government, the generating capacity at Grand 'Mere and Shawinigan Falls will be about 480,000 h.p. and a future development at Gres Falls will raise this to over 600,000 h.p.

Future Growth and Utilization of Water Power

Considering the history of water power utilization in Canada during the past few years in conjunction with the present activity with a view to making some reasonable forecast as to its probable future growth, the following may be deducted. Should the rate of water wheel installation during the past 15 years be maintained, there will be installed, in 1925, 3,360,000 h.p.; in 1930, 4,110,000 h.p.; in 1935, 4,860,000 h.p.; and in 1940, 5,600,000 h.p. There is every reason to anticipate that the rate of growth in utilization will be accelerated rather than retarded. Reference to the foregoing totals of water power available will indicate that this anticipated increase in utilization will not seriously reduce the total reserve. Canada possesses sufficient reserves of water power to meet the anticipated demands for many years to come.

W. L. Morse, chairman; R. Beeuwkes, Vice-Chairman; J. C. Davidson, G. Eisenhauer, R. H. Ford, Sub-Committee.

Electrolysis

Your committee has co-operated during the past year with the American Committee on Electrolysis and can report that substantial progress has been made. The American Committee on Electrolysis have completed a comprehensive report which has the unanimous approval of all the representatives of the following organizations:

American Railway Engineering Association.
American Electric Railway Association.
National Electric Light Association.
American Institute of Electrical Engineers.
American Gas Association.
Natural Gas Association.
American Telegraph and Telephone Company.
American Water Works Association.
National Bureau of Standards.

The report will be distributed before the March meeting of the American Railway Engineering Association in Chicago.

Co-Operation With the U. S. Bureau of Standards

The committee was directed to continue co-operating with the U. S. Bureau of Standards in the revision of the National Electrical Safety Code.

The Code purports to establish a National Standard of Safety for the users of electrical apparatus. In general the standard is satisfactory and in accordance with good practice.

The rules establish minimum requirements. Greater margins of safety are not prohibited. The Committee does not therefore fail to support the Code when it suggests greater safety provisions.

It was not the intention of the Bureau of Standards that the Code should be regarded as a designing specification. It is therefore not inconsistent that the Code be supplemented by working specifications that specify factors of safety not less than those established by the Code.

The Committee recommends that the Railroad Specifications for Electric Light, Power Supply and Trolley Lines Crossing, Steam and Electric Railways, adopted by the Association, and printed in the Proceedings, be opened for revision with a view to make them conform with the Code as far as consistent with established railroad standards, conferring with other interests giving special attention to the following items:

(1) Definition of the Grades of Construction.
(2) Minimum Overhead Clearances.
(3) Clearances between Lines and between Conductors and Supports.
(4) Minimum size and material of conductors.
(5) Unit Stresses in Steel and Wooden Crossing Supports (Factors of Safety).
(6) Grounding of Arms and Guys.
(7) Grade of Construction on Branch Lines.

E. B. Katte, Chairman; D. J. Brumley, Vice-Chairman; R. D. Coombs, L. S. Wells, S. Withington, Sub-Committee.

Overhead Transmission Line Construction

The Committee was instructed to study and report on overhead transmission and distribution line construction for railroad use, and prepare plans and specifications for such construction, co-operating with the appropriate com-

mittees of the Signal Section as well as with the Telegraph and Telephone Section of the American Railway Association.

The Telegraph and Telephone Section of the American Railway Association has done valuable work towards standardizing pole line construction for telegraph and telephone lines.

By far the greatest experience and development in transmission and distribution line construction has been that of the electric power companies. It seems probable that types of good construction which have proved satisfactory for them may be adequate for lines of a similar class for railroad use. However, the proximity to railroad tracks presents hazard to trains from pole and wire failures which is important consideration. The most important difference would probably be that railroad lines are usually confined to restricted right-of-way. The railroads may properly take advantage of a cleared private right-of-way by adopting smaller overhead clearance. Railroad engineers must often adopt types of construction adapted to growth on a single line, whereas power companies may frequently develop with advantage through loops or alternative routes.

A particularly unfavorable location for an outside line from the railroad point of view is that parallel to the right-of-way and immediately outside the property line. Many instances of this sort exist and in some cases there is serious conflict between such outside lines and the low voltage circuits of the railroad.

The Committee recommends that the subject be continued with a view of submitting next year Standard Transmission Line Specifications for the approval of the Association.

S. Withington, Chairman; R. D. Coombs, Vice-Chairman; H. M. Bassett, F. D. Hall, L. S. Wells, R. Beeuwkes, Sub-Committee.

Clearances—Third Rail and Overhead

The Committee communicated with an official of each electrified steam railroad; has revised the record tables and brought them up to date.

The Committee recommends that these tables be accepted as information and published in the Proceedings.

NOTE:—The tables referred to are too lengthy to be included here.—Ed.

H. M. Bassett, Chairman; A. E. Owen, Vice-Chairman; H. K. Lowry, E. J. Correll, F. D. Hall, Sub-Committee.

Collaboration With Committee on Economics of Railway Location

The Committee was directed to collaborate with the Committee on Economics of Railway Location as affected by the introduction of electric locomotives. Although we have offered our services and they have been willingly accepted, no opportunity to effectively co-operate has been afforded, up to the time of submitting this report.

Because of the importance of the subject, it is recommended that collaboration with the Committee on Economics of Railway Location be continued.

D. J. Brumley, Chairman; W. L. Morse, Vice-Chairman; R. Beeuwkes, J. V. Duer, J. C. Davidson, S. Withington, Sub-Committee.

Standardization

The Committee on Standardization submitted to the Committee the standardization of one or more of the following articles:

(a) Insulators.
(b) Friction, rubber and other tapes.
(c) Knife and snap switches.

The Committee elected this year to report on friction and other tapes.

After the review of the more general specifications for tapes, and considering the late activity of the American Society for Testing Materials, resulting in completion of tentative specifications for these tapes, the Committee was inclined to advance them for recommended adoption by the A. R. E. A., if upon review they could be found satisfactory for its work.

It is the recommendation of your Committee that these specifications be adopted as recommended practice and printed in the Manual.

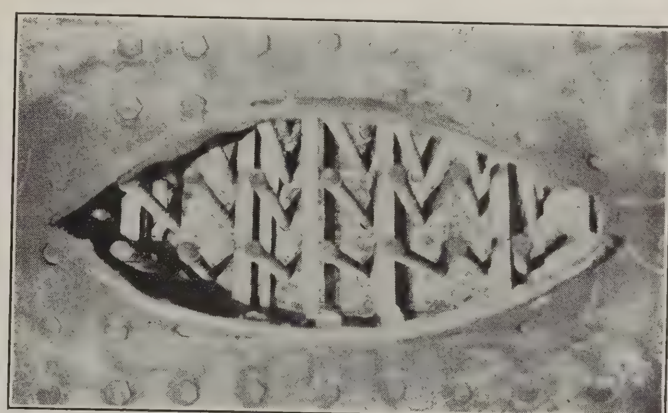
NOTE:—Specification too lengthy to be included here.—Ed.

H. K. Lowry, Chairman; S. Withington, Vice-Chairman; M. Schreiber, J. C. Davidson, L. S. Wells, Sub-Committee.

Locomotive Boiler Accidents

According to the report of the chief inspector of locomotive boilers of the Interstate Commerce Commission for the fiscal year ending June 30, 1921, the number of accidents, as well as the percentage of locomotive defects, shows a decrease. As may be seen from the photographs, the autogenous welding of crown sheets is evidently attended with serious liability to boiler explosions.

During the year there was a number of accidents investigated in which firebox seams, formed by the autogenous welding process, were involved, where, through the failure of these seams, it is believed the result of the



Crown Sheet Failure Caused by Low Water; Seam Had Been Autogenously Welded

accident was much more serious than would otherwise have been. Autogenous welding can be used on many parts of the locomotive and tender, and on parts of the stayed surfaces of the boiler with safety and economy, but inasmuch as the accident investigation showed approximately 80 per cent of the autogenously welded seams fail, where they are involved in the accident, it is believed that such methods should be avoided in firebox crown sheet seams, where overheating and failure are liable to occur, or on any part of the boiler where the

strain to which the structure is subjected, is not carried by other construction which fully meet with the requirements of the rules. At least, this should be the practice until some means have been developed through which the quality and tenacity of the weld may be established in advance of its failure. This should apply on all parts of the locomotive and tender where, through failure, an accident and an injury might result.

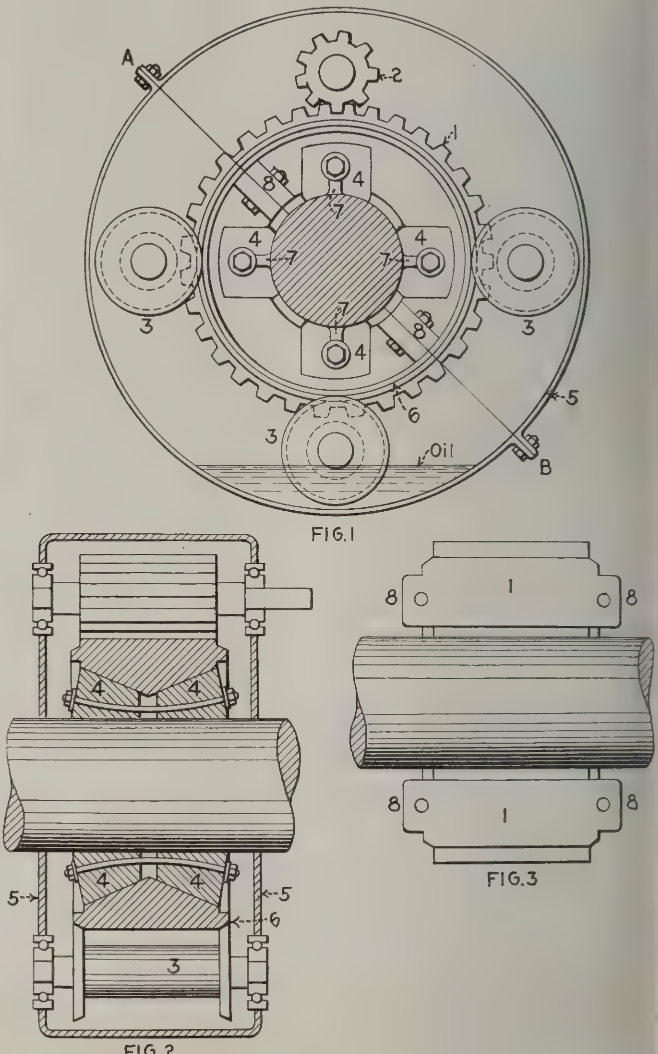
Low Water Caused Crown Sheet Failure and Boiler Explosion

Positive Drive Axle Device

In the January 1921 issue of the *Railway Electrical Engineer,* page 38, there was described a scheme for eliminating the belt drive commonly used with car lighting generators. The inventor of this device, A. H. Matthews, has since collaborated with W. F. Aves, and together they have improved the original design as shown in the illustration.

Referring to Fig. 1, the drive consists of a spur gear (1), a pinion (2), 3 spools or rollers (3), an expanding bushing, consisting of 8 plugs and bolts (4), and a casing (5). The casing serves to support the pinion and rollers and to prevent dust and other foreign substances from entering the gears. It also holds the oil for lubricating the several parts and this lubrication helps to prevent noisy operation. The pinion is preferably made of rawhide in order to further facilitate quiet running.

A feature of this drive is its compactness, simplicity, and the ease of applying to the axle. The spools (3) have a beveled flange as may be seen in Figs. 1 and 2. This flange fits the beveled ledge or runway (6) on the large gear, thus keeping the device in alignment and also keeping the pinion in mesh with the large gear. Fig. 3 is a sectional view of the gear through the line A-B, Fig. 1. The gear is fixed to the axle by means of the taper plug and bolts (4), Figs. 1 and 2. These plugs are cut away at 7, Fig. 1, to allow the bolts to be easily slipped through and fastened. The spools and pinion are fixed to the casing by means of ball bearings. The shaft of the pinion projects at one or both sides, and to this projection is attached the shaft that drives the generator, connected by means of bevel gears or otherwise. The shaft connecting the drive with the generator, may consist of two universal joints, a flexible coupling and a friction joint, the friction joint being for the purpose of permitting a certain amount of slip between the generator shaft and the driving device. Fig. 1 illustrates the method of fastening the two halves of the large gear with bolts and lugs.



Construction Details of Positive Drive for Car Lighting Generator

The inventors have applied for the patent rights of this device for both the United States and Canada.

Photo by Keystone View Co.

A Harlem River Dock with a Crane Which Unloads a Lighter and Loads a Car or Truck In One Operation

Typical Roundhouse Scene on the St. Paul

Standard Roundhouse Lighting on the St. Paul

Method Adopted After Two-Year Trial Requires Only One-Half the Power Consumption of Prior System

AFTER a two-year trial, the Chicago, Milwaukee & St. Paul Railway has adopted a standard method of lighting its roundhouses, using enclosed reflector units mounted on the walls. In February and March of 1919, the roundhouse at Milwaukee, Wis., was completely rewired and the new lighting units were installed.

Arrangement of Lighting Units on the Roundhouse Wall

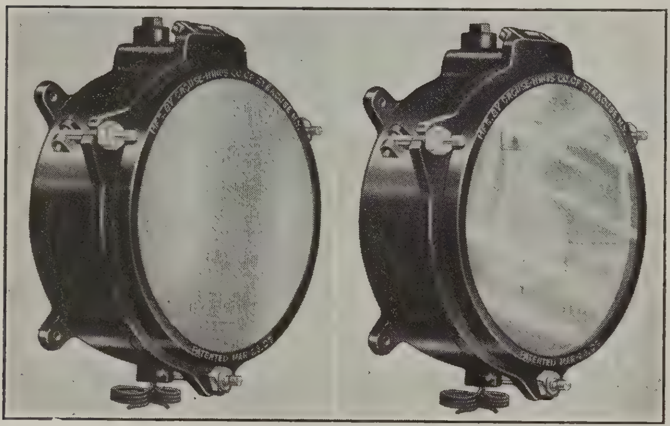
As shown in the illustration two units are used for the illumination of each stall and are mounted on the wall about eight feet from the floor. These units are the Crouse-Hinds No. 26067 with an enameled steel reflector, using a 100-watt lamp. At the rear of each stall mounted on the door post is another unit Crouse-Hinds No. 26051, using a 60-watt lamp, which throws the light down between the two locomotives. Mounted on the middle post of each stall is an extension plug type K and J condulet with the Hubbel attachment. At the time the lighting units were installed they were blocked out from the wall and focused and fastened in place, which arrangement has been permanent and it has not been found necessary to change the adjustment. All of the lamps are energized at 220-volts direct current.

The circuit for each 18 stall section is fed from one central distribution panel. The lights from three stalls are fed on one circuit, which is connected to two fuses and a double-pole single-throw switch in the panel. The extension circuits are on a separate switch and fuse and are energized at all times. Kerite insulated wire is used throughout, No. 12 or No. 14 being used, depending upon the distance from the distribution panel. Three-quarter inch conduit is run from the several lighting units to the top of the roundhouse. All other wiring is run openly on porcelain knobs in the top of the roundhouse. Such conduit as is used up the side of the wall and on the posts is used as mechanical protection alone, it being the experience of the electrical department of the St. Paul that Kerite insulated wire will last longer than any conduits which they have previously used for protection in roundhouses. In some cases conduits have been known to rust out, in the top of roundhouses, in the course of two or three years. However, it is expected that the present system of wiring in this roundhouse will last for at least ten years.

Previous methods of lighting this roundhouse consisted of a single open reflector using a 500-watt lamp, mounted between the stalls behind the first post. As only 260 watts are now used, there is a saving of 240 watts. With the old single units mounted near the roof it was found to be very diffiuclt to keep the lamps and

reflectors clean. Whereas with the new units it is merely a proposition of rubbing off the front of the glass and the illumination is again efficient.

It has been found that since these new units were installed that out of 120 lamps in service there are only between 8 and 9 renewals of the 100-watt lamps and 6 or 7 of the 60-watt lamps, per month. Considerable has been saved in the theft of lamps themselves. As these Crouse-Hinds units are considered to be strictly gas tight, it is necessary, only once a month to open up the units,



Types of Lighting Units Showing Diffusing and Clear Glass Lenses

clean out the reflectors and check up on the lamp itself. This work is done entirely by an electrician's helper and requires only a few hours for the entire installation. Whereas, heretofore it required the duties of one electrician practically full time to take care of the illumination of these two roundhouses. This item alone has been the means of effecting considerable economy in favor of the new system of lighting.

Herbert Hoover on Superpower Development

"WE ARE all aware of the results obtained in the investigation of the superpower development of the Atlantic seaboard. Superpower is not impossible in many other sections of the country. We are indeed on the threshold of enlarging the distances of transmission. We have the possibility of reducing waste through a large phase of electrical development made during the past thirty years. The American people have no appreciation of the possible results and the added efficiency, productivity, safety and advance that could be obtained in the enlargement of our entire electrical equipment. And there is nobody that could give this problem such consideration and so illuminate it in the national sense as this Council could do. It indeed requires the services of every branch of engineers that compose the Council. With the possibility ahead of us of the development of some twelve to fifteen millions of horsepower, the consolidation of hundreds, even thousands of minor plants, the enormous savings to be made through the substitution of electrical power for steam—in that there is a probability of the greatest material saving of waste possible in any country in front of the American people."—From an address before the First Annual Meeting of the American Engineering Council.

Experimental Automatic Stop Device on Great Central, England

THE automatic stop device illustrated herewith was developed on the Great Central (England). The principle on which it is based is well shown in the illustration, i.e., when the section is not clear the track instrument operates to place an obstruction in the way of the wooden prop on the locomotive mechanism. If the locomotive passes the track device in such a position, the prop, naturally, is knocked down with the result that the lever, held by the prop in a horizontal position, is released. This action brings about the application of the brakes. The engineman cannot release the brakes until he has placed another prop under the brake lever.

This device is used in connection with another, placed

Photo by Kadel & Herbert

before it on the track, which gives an audible signal to the engineer when the track is not clear. Only if that signal is disregarded does the device illustrated here come into use.

Fifty removable highway bridges are maintained by the city of Chicago, the different types being as follows: 24 trunnion bascule bridges, 12 center bearing swing bridges, 12 rolling lift bascule bridges, one vertical lift bridge and one pontoon bridge. Of the trunnion bascule bridges, 22 are of the type developed by the city and the others are of the Strauss and Page & Schnable types. The pontoon bridge is across the Calumet River at Torrence Ave.

G. R. S. Company's Auto-Manual Train Control

A System Which Retains All the Advantages of Visual Signals and of the Enginemen's Brain

THE drawings and photographic illustrations shown in Figs. 1 to 6, inclusive, illustrate the automatic train control system of the General Railway Signal Company, of Rochester, N. Y., which recently has been improved in various details. An essential element of this system is the arrangement for permitting the engineman, when alert and watching for and obeying the visual

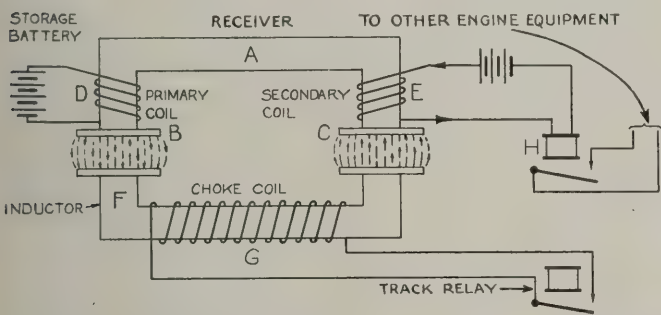


Fig. 1—Inductive Train Control

signals, to cut out the automatic brake-setting machinery and thus keep in his own hands full control of his train; and this is the reason for the name adopted, "auto-manual train control." The cutting out device is so arranged that the engineman must have the co-operation of the fireman, thus insuring that it shall not be used unless there are two men alive and active on the locomotive; and the circuit breakers are so combined in a small box that no

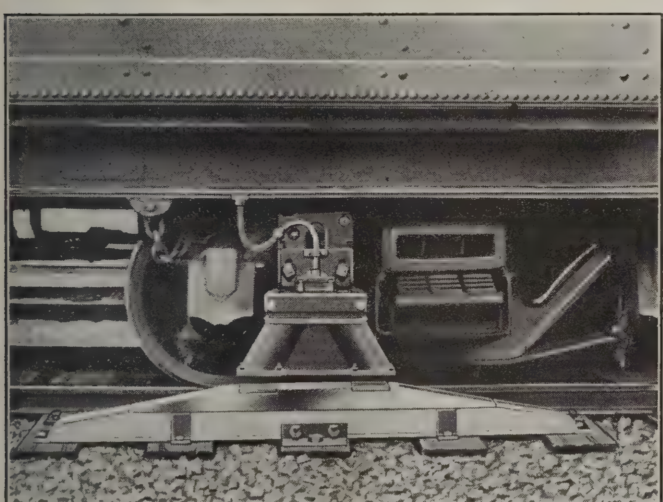


Fig. 2—Receiver on Tender; Inductor on Ties

cut-out can be continued for a longer time than ten seconds; this to thwart the lazy engineman who might wish to cut out the stop apparatus for a whole run. If an engineman does allow his train to be automatically controlled, it must come to a stop before the control can be released.

From a detailed account furnished by the manufacturer, we condense the following description:

The means by which control is transmitted from the roadway to the moving train is induction, employing the inductor-alternator principle, as illustrated in Fig. 1. The inductor *G* is fixed on the ends of the ties with the pole faces 2½ in. above the top of the running rails. The receiver or locomotive element *A* is carried on the tender truck so that its pole faces pass about 2 in. above the pole faces of the inductor. On one leg of the receiver is placed a primary coil *D* fed from a storage battery. A secondary coil *E* on the other leg of the receiver includes in its circuit a storage battery and a relay *H*. The magnetic flux in the secondary coil, remaining constant in amount, keeps the flow of current through the relay likewise constant and holds the relay contacts closed. This is the normal condition on the locomotive. When, however, it passes a control point, if the circuit of the choke coil *G* is open, the inductor, partially completing the mag-

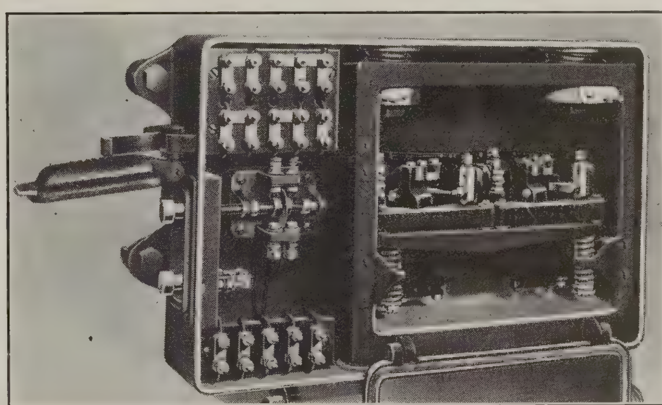


Fig. 3—Reset Key, Battery Switch and Relays

netic circuit of the receiver, will cause a large change of magnetic flux within coil *E*, which in turn will result in a sufficient variation of current to open the relay. The relay, when open, causes a brake application.

If, as the locomotive passes, the circuit of coil *G* is closed (by the track relay of the track section to which this control applies) this coil will then act as a choke, preventing the magnetic flux from varying materially in the secondary coil of the receiver; the engine relay will not be opened and the train will not be stopped.

It is to be noted that the coil on the inductor is never supplied with energy; the only thing necessary to make the inductor effective to stop a train is the opening of this no-battery circuit. Thus is avoided all trouble or expense to provide a roadside current-supply for train-control purposes. The inductor is of course uninfluenced by sleet, snow, water, etc., and is not affected by stray magnetic fields from passing electric locomotives or current in the propulsion rails. It is on an oak foundation with a manganese steel cap on the top. The manganese steel, being fairly non-magnetic, does not interfere with the proper function of the inductor.

Fig. 2 shows the inductor and the receiver. The receiver is fitted in between the projecting springs and jour-

nal box of the truck frame of the tender. It is adjustable vertically to compensate for wheel wear. It is resiliently supported by a cast steel structure fastened directly to the truck frame, in such manner that no car springs intervene between it and the axles.

The engine relay, Fig. 3, is so housed and supported as to be immune to the effects of locomotive vibration. It has a very light, short armature mounted on jeweled bearings. Two relays are employed, a primary and a secondary. The primary relay, designed to be especially rapid in action, takes a very small amount of energy. The secondary relay need not be rapid in action and is provided with heavy carbon to metal contacts, giving a wide break and is capable of continuous and satisfactory handling of the current taken by the electropneumatic valve.

These two relays are resiliently supported in an inner housing, said housing being purposely made heavy, about 70 lb. This inner housing being in turn resiliently supported in the relay box proper, engine vibration is prevented from reaching the relays. The inner enclosure in addition prevents frost troubles and the accumulation of dust on the relays.

The Brake Setting Apparatus

The brake setting apparatus consists of an electropneumatic valve, controlling a cylinder which is directly connected to the engineer's brake valve handle (Fig. 6) with a mechanism so designed that the valve will automatically move to the service application position without danger of jumping to the emergency position. The engineer may at any time put on the emergency if he so desires; or, by exerting heavy pressure against the brake handle, he can modify an automatic brake application. Absence of air permits a heavy coil spring within the cylinder to move the brake handle to the service position. The spring is so designed and protected that even if it should break, it would continue to operate reliably.

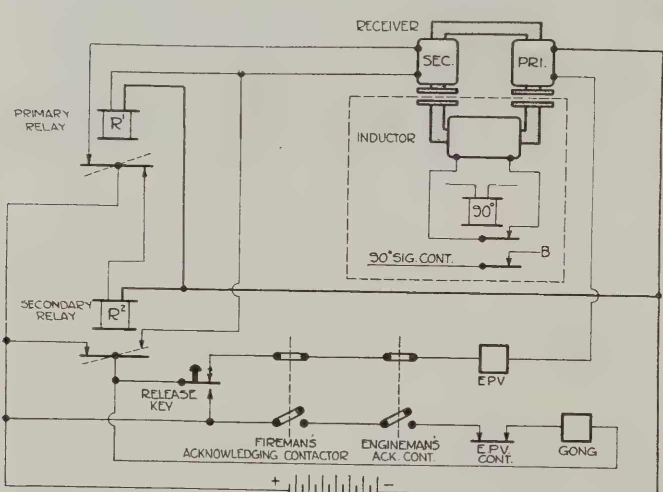


Fig. 4—Circuits of Auto-Manual Train Control

As before stated, the engineman who permits automatic application of the brakes can release them only after the train has stopped. The reset key, with front and back contacts, is fixed on the side of the tender midway between the front and the back end, and is so connected in the circuit that if operated following an automatic application of the brakes, it will restore the automatic control equipment to normal. If an attempt should be made to lock the key in its release position it would cause an application of the brakes, it being necessary in the process of restoring the automatic control equipment to normal, to first push the plunger in and then allow it to come back to its normal position.

Reversing Switch and Acknowledging Contactors

In order to set up the proper combination so that the engine will not be under control when operating against the current of traffic, a reversing switch is employed, and arranged to be operated by one of the axles of the locomotive or tender. This is so fixed that the direction of rotation of the axle automatically puts into commission the equipment on the right side of the locomotive, with reference to the direction in which it is moving. There is a receiver on each side of the locomotive.

Automatic Cylinder on Brake Valve and Acknowledging Contactors

To make the system "auto-manual" there is provided an "acknowledging contactor" for the engineman and also one for the fireman. A contactor (Figs. 4 and 5) has a normally closed and a normally open contact. The normally open contact is closed when the lever is depressed, and when closed it prevents a brake application. The normally closed contact is controlled by a time mechanism so that it will open after the lapse of ten seconds, thus making it useless for engineman or fireman to attempt to tie or lock the lever down. Ten seconds represents about 900 ft. of train travel at 60 miles an hour.

The two acknowledging contactors are connected in series, so that the engineman and the fireman must operate them simultaneously, in order to forestall an appli-

cation of the brakes. The fireman's lever is under the left window sill and engineman's under the right window sill. To the objection that the fireman's duties would prevent him from operating the contactor it is replied that he need only acknowledge restrictive signals; and on most railroads he is required to call signals, both favorable and adverse.

Current Supply and Speed Control

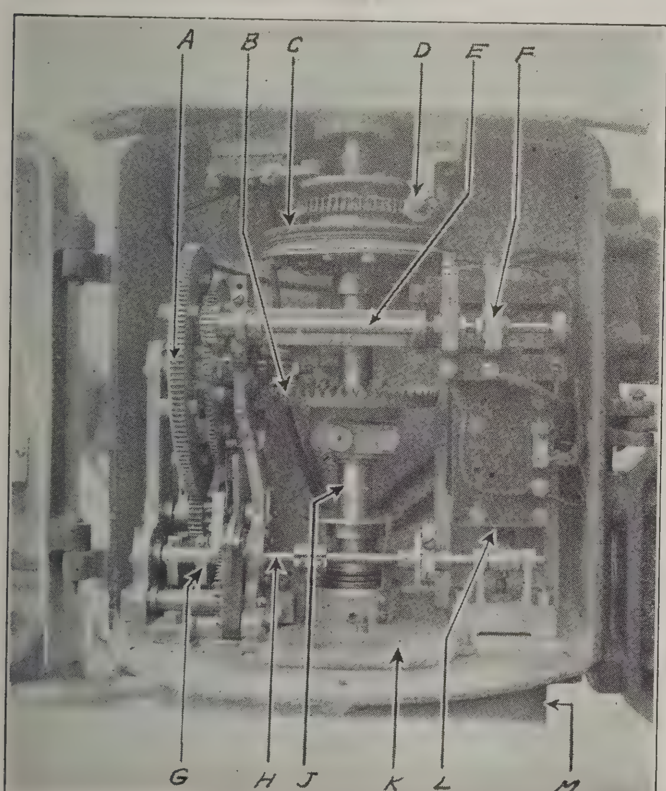
The current supply for the automatic train control equipment on the locomotive may be taken from the turbo-generator direct or from a storage battery independently charged or from a storage battery of smaller capacity floated across the turbo-generator and provided with the usual reverse current relay to prevent its discharge in case the turbo-generator voltage should fall unduly. There are required about 25 watts continuously while the automatic control is in effect. A cut-out switch is placed in the relay box so that the battery current may be cut off when the locomotive is out of commission.

This system readily provides for permitting a train to move up to a stop signal without an automatic application of the brakes and without the use of acknowledging contactors, by the use of inductors placed along the road in combination with a time mechanism on the locomotive, the whole so organized that if a train passes from one inductor to the next with speed sufficiently reduced, no brake application will take place. Upon reaching the second inductor, the time mechanism will again have closed its circuit so that it would not cause a brake application. This speed control arrangement is exceedingly flexible and comparatively simple, involving the same kind of parts as would be used in connection with an automatic stop, except that the time contactors are added. Speed restrictions are instantly removed when and if the signal ahead shows a more favorable indication.

The Federal Signal Company's Audible Signal

Interesting Experiments on the Boston & Albany in Massachusetts and New York

THE Boston & Albany has in use two audible roadside signals, installed by the Federal Signal Company, of Albany, N. Y., last September, which have given very satisfactory service, functioning as distant signals;



Federal Audible Signal

an audible warning (a torpedo) sounded in conjunction with the visual indication given by the three-position automatic semaphore. The torpedo is in position to be exploded by the passage of a train, at all times when the semaphore is in the 45-degree position. When the semaphore goes to the clear (90-degree) position the audible apparatus is cut out. The signals are on the westbound track of the main line, one at East Brookfield, Massachusetts, and one at Chatham, New York.

This apparatus was first put on the market by the Federal company several years ago, and one of them has been in use at Salmon Bay drawbridge, on the Northern Pacific, in the State of Washington, since 1914; but numerous changes of detail have been made in the design since that year. The cutting-out arrangement (by which an approaching engineman, after seeing the visual signal, can prevent the explosion) which has been a feature of the descriptions heretofore published, is not included in the Boston & Albany installation. (On the Northern Pacific the torpedo apparatus is at an interlocked stop signal and has never been exploded by a train. It is tested once a month.)

The Boston & Albany signals have operated without failure since they were installed, six months ago. They have been subjected to severe winter weather, and a heavy train service. The signal may be called a repeater of the caution indication, but it operates independently of the visual signal.

The shell magazine in the audible signal is designed to hold 72 shells, and is so interconnected with the semaphore that when the magazine approaches exhaustion the semaphore blade is set in the horizontal position against approaching trains. On the Boston & Albany reloading once in about two weeks is sufficient, explosions taking place on an average of 25 a week at each signal.

The mechanism is shown in the illustration, the torpedo drum being at the bottom of the case. The drum is rotated by means of a large weight which tends at all times to bring a new cartridge into firing position. This is accomplished by de-energizing a holding winding on the

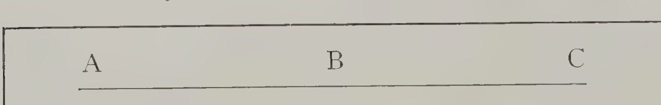
operating solenoid. When a cartridge has been fired, the operating weight indexes a fresh cartridge to the firing position so that the succeeding pick-up of the track relay (when the train has passed out of the block) will again put the mechanism in condition to repeat the firing operation. Check contacts are provided to insure that the audible signal is in a firing position before the signal control circuit is completed, so that the audible signal must be in firing condition before the visual signal can indicate either "proceed" or "proceed with caution."

The mechanism case is mounted on a short post (iron pipe). This is set about 60 ft. in advance of the semaphore so that the explosion, which occurs about one second after the leading wheels of the train pass the signal post (and open the track relay) will sound at the moment when the engineman in the cab is nearest to it.

Within the post is suspended the operating weight, which is attached, by means of a cable, running over a grooved pulley to the main operating sheave *C*. The weight tends to rotate a main shaft *J*, at the lower extremity of which is mounted the drum carrying the cartridges (inside of *M*). Rotation of shaft *J* drives, through the medium of the bevel gears *B*, the spur gear *A*, which in turn cocks the firing hammers as each cartridge is indexed to the firing position. The hammers are held cocked by the triggers *G*. These triggers are carried on a trigger shaft *H* connected to the plunger of the solenoid core *L*. Thus, as the core *L* drops, the trigger *G* is disconnected from the firing hammer and one cartridge is exploded. The apparatus can be adjusted to provide for any number of explosions at each operation.

After the explosion, the drum is indexed by the weight to the new firing position. As soon as the solenoid core *L* is picked up the circuit controller *F* will close, to permit the semaphore to again clear. The controller contacts are in timed relation to the firing position of the magazine, through the medium of the gears and pinions on the left hand extremity of the shaft *E*. The shaft *D* is provided for disconnecting the operating weight when it is necessary to replenish and reload the magazine. Access to the firing chambers is provided through a hand hole plate *K*.

The control of the explosion of the cartridge so that it will occur only on the passage of a train, and at the moment that the locomotive passes nearest to it, is accomplished by means of a contact on the track relay. Assuming that the leading train—the train to be protected—is in section *B-C*, the semaphore at *A* is at caution: and as the following train reaches *A* its leading wheels, by opening the track relay at that point, cause the semaphore arm



to move to the stop position and also cause the opening of a circuit to the solenoid which controls the release of the trigger that causes the explosion of the cartridge.

Fifty Per Cent is the reduction reported by the Philadelphia & Reading in the number of fatal accidents to employees in 1921, as compared with 1920; sixty-eight killed in the last year and 34 in the year before. There was also a material reduction in the number injured.

Comparative Test of Bare and Coated Welding Electrodes

In a comparative test of bare and coated welding electrodes, recently conducted in an industrial plant, a material increase in the amount of metal deposited per unit of power consumption and per unit of time, together with a marked decrease in the percentage loss of metal were the results which were found to accompany the use of coated electrodes.

The first two tests consisted of welding together two pieces of 3/8-in. tank steel plates the edges of which had been beveled to facilitate the welding. In the first test 5/32-in. bare electrodes were compared with 5/32-in. coated electrodes of two grades, designated as No. 1 and No. 6. In the second test 1/4-in. electrodes were used. A third test was made using 5/32-in. coated electrodes in welding together two pieces of cast iron plate. In each case the plates and the wire were weighed before and after the test on a scale weighing accurately to one-half ounce to determine the loss of metal; time was taken with a stop watch and power consumption measured by an Esterline curve drawing watt meter.

Comparisons of the two types of electrodes from the standpoint of metal deposited per hour and per kilowatt hour and the metal loss per pound deposited are set forth in the table. All of the tests show an advantage for the coated wire in the matter of metal deposited per kilowatt hour and also per unit of time. If the metal deposited by the 5/32-in. bare electrodes be considered 100 per cent, then that deposited by the 5-32-in. coated electrodes showed increases of 22 per cent for the No. 1, 69 per cent for the No. 6 on the steel plate and 43 per cent for the No. 1 on cast iron. Comparing in the same manner the 1/4-in. coated electrodes used on steel plate with the 1/4-in. bare electrodes, the No. 1 coated showed an increase of 10 per cent in the amount of metal deposited per unit of power consumption while the No. 6 coated electrodes showed an increase of 44 per cent.

Results of Comparative Tests of Bare and Coated Electrodes

Test No.	Electrode	Pounds of electrode: Lost by vapor, etc. per lb. deposited	Pounds of electrode: Deposited per hr.	Pounds of electrode: Deposited per kwh.	Kwh. per lb. deposited	Hours per lb. deposited
I	5/32" Bare	.43	1.543	.336	2.97	.65
I	5/32" Coated No. 1	.00	1.875	.407	2.45	.534
I	5/32" Coated No. 6	.00	2.560	.568	1.76	.391
II	1/4" Bare	.38	2.76	.368	2.72	.362
II	1/4" Coated No. 1	.09	2.85	.405	2.47	.351
II	1/4" Coated No. 6	.00	3.79	.541	1.85	.264
III	5/32" Coated No. 1	.00	2.19	.481	2.08	.457
	Average for bare electrodes	.40	2.15	.352	2.84	.506
	Average for coated electrodes	.018	2.76	.479	2.12	.384
	In favor of coated	.382 lb.	.61 lb.	.127 lb.	.72 kwh.	.122 hrs.
	Advantage of coated electrodes in per cent	95.5	28.4	36.1	24.4	24.1
	Saving in dollars per lb. deposited at 9.25 cents per lb.	$0.0353	....	....	*....	†....

*At 3 cents per kwh. equals $0.0216.
†At 65 cents per hr., equals $0.0793.
Total, $.1362.

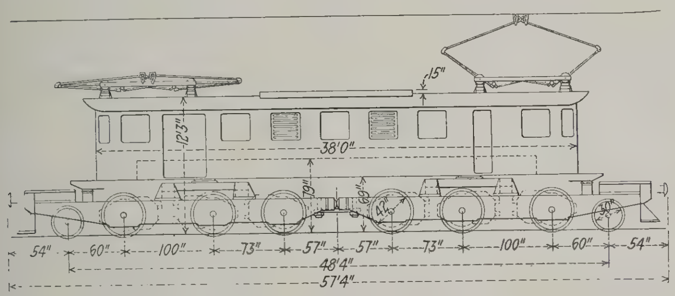
Comparing the metal deposited per unit of time in the same manner, increases of 22 per cent and 46 per cent respectively for the No. 1 and No. 6 coated electrodes on steel plate and 42 per cent for the No. 1 electrode on cast iron, were shown as compared with 5/32-in. bare electrodes on steel plate. A similar comparison for the 1/4-in. electrodes showed increases of 3 per cent and 38 per cent respectively for the No. 1 and No. 6 coated electrodes as compared with the bare electrodes, all tests being made on steel plate.

Chilean Railways' Electric Passenger Locomotives

Two Types Provided for Express and Passenger Service— Express Locomotives Will Use Regenerative Braking

A TOTAL of 39 electric locomotives are to be supplied to the Chilean State Railways in the contract which provides for electrifying the section from Santiago to Valparaiso. This includes 6 express passenger locomotives, 11 for local passenger service, 15 for road freight service and 7 switchers.

The contract was awarded to Errazuriz, Simpson & Company, a Chilean firm, and all electrical equipment will be furnished by the Westinghouse Electric International Company. Conditions which must be met and the manner in which electric traction will be used to meet these conditions were described in an article in the January, 1922, issue of the *Railway Electrical Engineer,* page 3.



Side Elevation of Express Passenger Locomotives

Express Passenger Locomotives

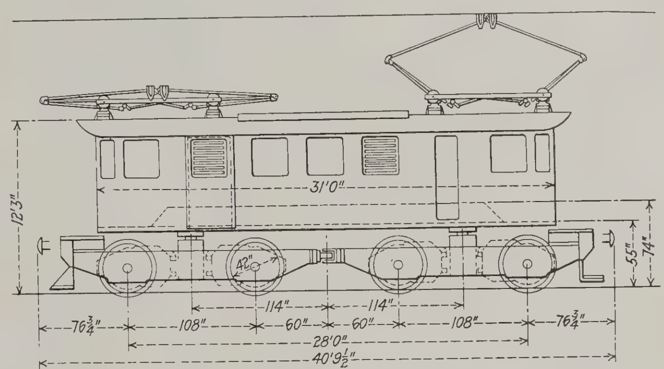
The six electric locomotives which are being built for express passenger service will be capable of hauling 300-ton trains in either direction between Valparaiso and Santiago without the aid of helpers as is now necessary with steam operation on the Tabon grade, between Llai Llai and La Cumbre. This type of locomotive will weigh 127 tons and will have 105 tons on the drivers. It will have a nominal rating of 2,250 hp. corresponding to a speed of 37 miles per hour at a tractive effort of 23,400 lb.

The wheel arrangement will be 2-6-0 + 0-6-2, consisting of two main trucks, each of which has three driving axles and a two-wheel guiding truck. The cab will be of the single box type and the motors will be geared direct to the driving axles.

Dimensions and Weights of Express Passenger Locomotives

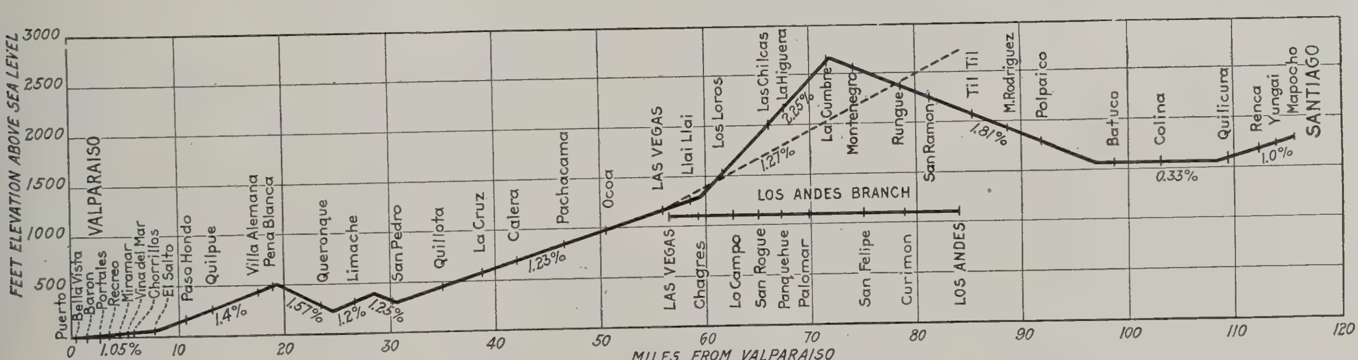
Classification	2-6-0 + 0-6-2
Length over buffers	57 ft. 4 in.
Length over cab	38 ft. 0 in.
Total wheelbase	48 ft. 4 in.
Rigid wheelbase	14 ft. 5 in.
Diameter of driving wheel	42 in.
Diameter of guiding wheel	30 in.
Weight of complete locomotive	253,600 lb.
Weight of mechanical parts	160,000 lb.
Weight of electrical parts	93,600 lb.
Weight per driving axle	35,000 lb.
Weight per guiding axle	21,800 lb.

The trucks will be connected at the inner ends by a drawbar held in tension by spring buffers. The frames will be cast steel, bar type, located outside of the wheels, connected by cast steel bumpers and crossties and carried on semielliptic springs over the journal driving boxes.



Side Elevation of Local Passenger Locomotives

The cab underframe will be of rolled steel longitudinal members connected by cast steel and rolled steel cross members. M.C.B. couplers will be used with Continental spring buffers. Although eventually all drawbar equipment on the Chilean railways will be changed to M.C.B. standard, the Chilean freight cars now use the Continental type drawhooks and for this reason the M.C.B. couplers will be provided with attachments for chain couplers.



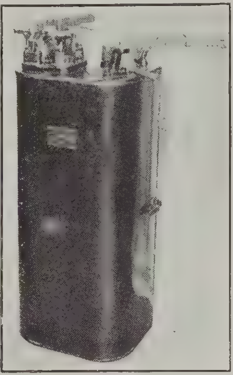
Profile of Zone to Be Electrified

The automatic air brake equipment will be the Westinghouse type 14-EL, a standard similar to that used on the present steam locomotives. With this equipment straight air is available for handling the locomotive alone and the automatic feature for both locomotive and train.

The locomotives will be equipped with six 275 hp. driv-

ing motors provided with field control and geared direct to the axles by Nuttall flexible spur gears. These motors are designed for operation in two series on 3,000 volts and will be grouped in three speed combinations, all six in series for low speeds, three in series with two groups in parallel for two-thirds speed and three groups each with two motors in series for full speed. There will be six running positions, the change from one motor combination to another being made by the shunting method.

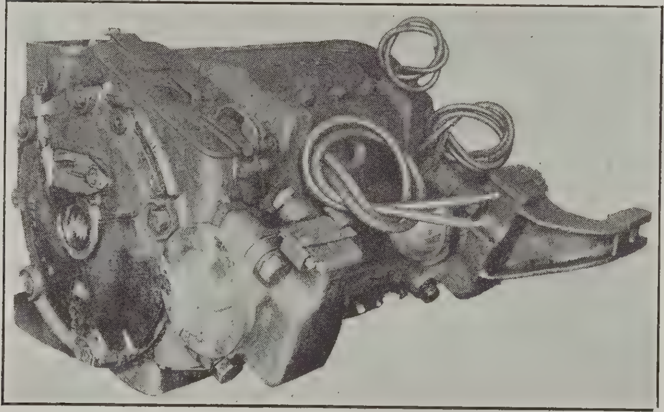
The control equipment is designed for operation of the locomotive from either end and provision for regenerative electric braking is included. This enables the locomotive to return energy to the overhead system when descending grades. The main motor armatures will be connected in the same combinations when regenerating as when motoring, the excitation for the motor fields during regeneration being supplied by a constant voltage motor-generator set.



The Master Controller for Express Passenger Locomotives

There will be two master controllers, one in each end of the cab, and the same controller will be used for both motoring and regulating. This controller will have four levers with a total of 51 notches available in the three combinations. Westinghouse type HLF control establishes the main circuit connections by the use of individual unit switches operated by compressed air controlled by electro-magnetic valves.

Motor-generator sets will supply low voltage current for the control equipment, blowers and compressors. This is a two-bearing type of machine with a common frame for both motor and generator. The normal rating of the set is 35 kw. at 95 volts with 3,000 volts at the motor terminals.



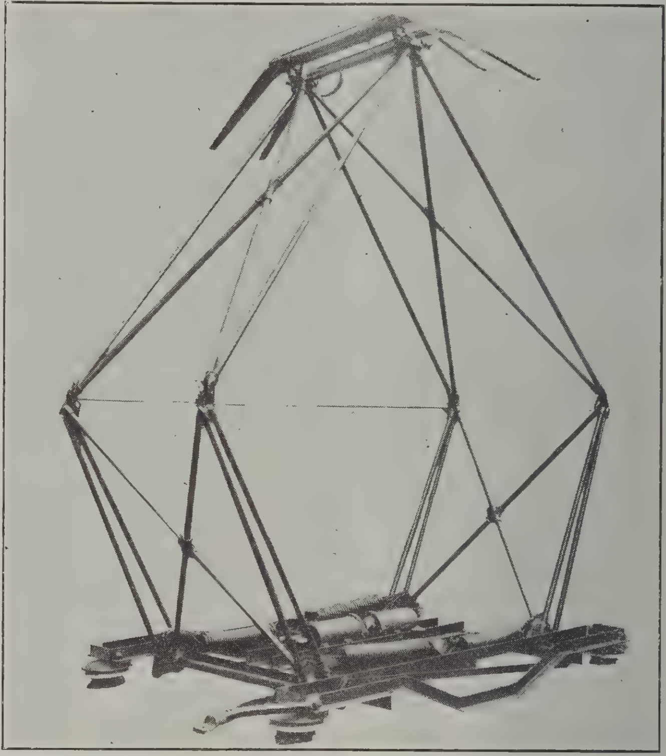
The 375 HP. Motors for the Express Passenger Locomotives Will Be Similar in Appearances to the Above

The current collectors will be spring raised, air lowered and mechanically locked in the lowered position and controlled throughout by compressed air.

On level tangent track these locomotives will have a running speed of 61.5 miles per hour when hauling a 300-ton trailing load. On the Tabon grade, which is 2.25 per cent, the average running speed will be 33.5 miles per hour. The maximum tractive effort based on 25 per cent adhesion will be 52,500 lb. and the maximum speed 62.6 miles per hour. The range of speed in regenerative braking will be 12½ to 50 miles per hour.

Local Passenger Locomotives

In general appearance the 11 electric locomotives for local passenger service will be somewhat similar to the express passenger locomotives. This locomotive will weigh 80 tons and the wheel arrangement will be 0-4-0 + 0-4-0. It will be capable of hauling a trailing load of 350 tons from Puerto to Vina del Mar, 260 tons from Vina del Mar to Llai Llai and return and 300 tons from Las Vegas to Los Andes and return. These locomotives will have a rating of 1,500 h.p. corresponding to a tractive effort of 15,600 lb. at a speed of 31 miles per hour. The maximum tractive effort under standing conditions will be 40,000 lb. and the maximum speed will be 56 miles per hour. The cab will be of the single box type and the motors will be geared direct to the axles. The general dimensions and weights will be as follows:



The Pantographs are Spring Raised, Air Lowered and Mechanically Latched in the Lowered Position. The Double Shoes Are Flexibly Mounted and Equipped with Hard Drawn Copper Renewable Wearing Strips.

Dimensions and Weights of Local Passenger Locomotives

Classification	0-4-0 + 0-4-0
Length over buffers	40 ft. 9½ in.
Length over cab	31 ft. 0 in.
Total wheelbase	28 ft. 0 in.
Rigid wheelbase	9 ft. 0 in.
Diameter of driving wheel	42 in.
Weight of complete locomotive	160,000 lb.
Weight of mechanical parts	96,000 lb.
Weight of electrical parts	64,000 lb.
Weight per driving axle	40,000 lb.

The two trucks, each having two driving axles, will be connected at the inner ends by an articulated coupling in the form of a Mallet hinge. The frame and cab construction, the couplers and the brake equipment will be similar to those of the express passenger locomotives.

The local passenger locomotives will be equipped with four 275 h.p. driving motors provided with field control and geared direct to the axle with flexible spur gears.

There will be two combinations by connecting the motors in series and in parallel and additional speed variations will be obtained by varying the fields of the motors.

The control equipment is designed for operation of the locomotive from either end but the grade conditions on the section of line on which these locomotives will operate do not justify the use of the regenerative braking feature. There will be two master controllers, one in each end of the cab, each controller having two levers, namely, speed and reverse, with a total of 23 notches available in the two combinations. The switching equipment duplicates that on the express locomotives.

The motor-generator set will be a double armature machine, each armature consisting of a motor and a generator. The normal rating of the set will be 22.5 kw. at 95 volts with 3,000 volts at the motor terminals. The current collectors will be the same as on the express passenger locomotives.

On level tangent track these locomotives will have a speed of 56 miles per hour when hauling a 220-ton trailing load. The maximum tractive effort based on 25 per cent adhesion will be 40,000 lb. A great many of the electrical and mechanical parts are interchangeable between the express and local passenger locomotives.

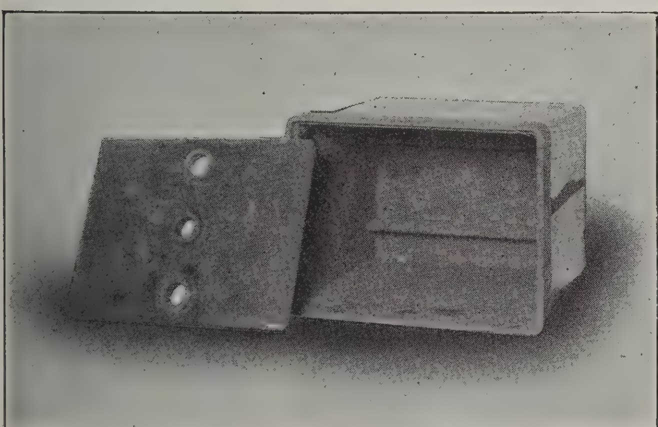
Use of Hard Rubber Battery Jars in Car Lighting

Santa Fe Has Succeeded in Reducing Battery Tank Maintenance to 30 Cents a Month Per Car

By A. E. Voight
Car Lighting Engineer, Atchison, Topeka & Santa Fe

HARD rubber versus lead tanks for use in storage batteries on electrically lighted cars, is a popular subject at the present time. In the early days of car lighting quite a few roads used hard rubber jars, but most of them abandoned their use on account of the heavy breakages they experienced. The Santa Fe was the only large road that continued their use and went into the subject of overcoming the troubles that were originally experienced, which resulted in the making of the jar as shown in one of the illustrations.

No doubt a good deal of the trouble that was experienced by some roads was due to their using plates that buckled and grew, thus breaking the rubber jars. This

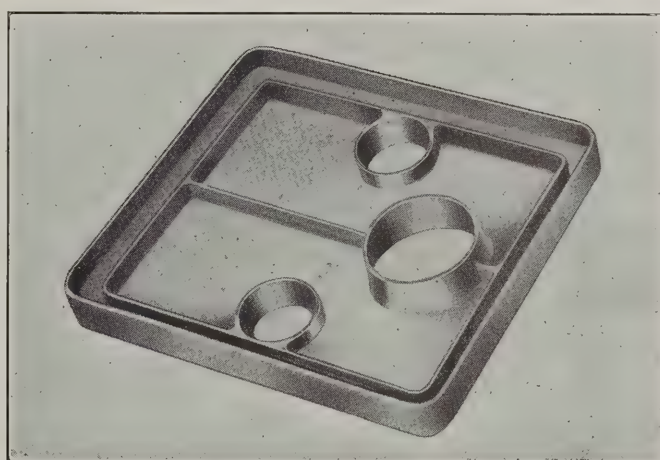


Hard Rubber Battery Tank and Rubber Cover. Bottom Rests are Moulded as a Part of the Tank

trouble has been reduced considerably by more modern equipments which protect the batteries from excessive overcharges. If a battery is not subjected to overcharge the plates will grow but little.

The assembly of jars in the crate was found to be an important factor, the best results being obtained where the jar fit snugly so as to give it the benefit of the mechanical strength of the crate. To accomplish this all space around the jar is taken up with thin wood blocks.

The location of side buffers on crates is of importance. We found it good practice to use a wood strip the full length of the crate instead of the short porcelain that was first used, as our experience showed that in cases of accidents or emergency stops, the buffer would sometimes be driven through the crate, resulting in the loss of a jar. The crate is made of yellow pine and dipped in hot paraffine before and after assembling.



Lead Antimony Cover for Use With Rubber Jar. Groove Contains Plastic Sealing Compound

The advantages of the rubber jar over the lead tank are as follows:

Lower first cost.

Freedom from grounds.

Freedom from leaks caused by chemical or electrolytic action.

Lower maintenance cost.

Experienced lead burner not required at all terminals to repair leakers.

In support of our statement of lower maintenance cost it may be stated that we have about 1250 sets of 16 cells

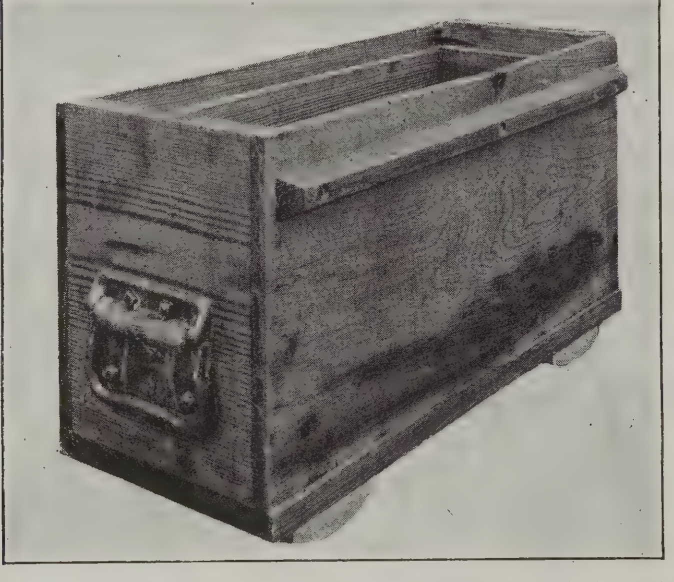
of batteries in service and our average jar costs per car per month for the past three years are as follows:

Business Cars $0.34	Smokers, Coaches, Chair and Comp. Cars $0.30
Diners and Cafe Observation $0.41	Pullman Cars $0.34

All of our diners and some of our business cars and cafe-observation cars are equipped with thirty-two cells of batteries. The above figures are about double what they were in 1917 as both the material and breakages went up during the war period. However, the figures show that it is only necessary to replace one jar out of a set of sixteen in thirteen months.

Another factor in cost that is done away with by the use of the rubber jar, is the side and end rubber liners and plate supports together with extra amount of labor and equipment that is necessary to assemble them.

The largest item of expense of upkeep experienced with lead tanks is due to leaks caused by electrolytic corrosion. If each lead tank could be perfectly insulated from the other tanks and from the ground, this corrosion could be prevented. It is, however, practically impossible to prevent grounds between tanks and the battery box. The wooden trays will become acid soaked and the porcelain skids will become covered with a layer of acid soaked dust, and thus a path for current from the tank to the ground is produced. When two such grounds exist in the same battery, even though of comparatively high resistance, a small amount of current will flow and any small amount of current flowing from one tank to another will start electrolytic corrosion which will pit the lead tank and cause it to leak. The thin rubber liners used in the lead tanks between the plates and the tank are another source of trouble. The constant rubbing of the plates against the liners will eventually puncture the liners and thus permit the plates to come in contact with the lead tank. This causes internal short circuits, shortening the life of the plates and involving considerable expense for renewing the hard rubber liners.



The Side of the Crate is Protected By a Long Wood Strip Instead of the Usual Porcelain Cleats

In sealing our jars we first convex our covers so as to make the vent plug the high point. This prevents dirt and foreign matter from being washed into the jar. We use a Form "H" soft rubber bushing of good quality in the cover around the terminal post. This bushing serves both as a seal and as a buffer which protects the jar and the sealing compound which holds the cover in place.

A lead antimony cover has recently been placed on the market for use with the hard rubber jars which has a double groove in which plastic sealing compound is placed, this results in the jar being automatically sealed when the cover is put in place. This lead cover also protects the top of the jar where most of the breakage occurs.

Electrically Safe Ending Boiler Tubes

By J. J. Sullivan
Superintendent of Machinery, Nashville, Chattanooga & St. Louis, Nashville, Tenn.

The recent revival of interest in the application of safe ends to boiler tubes and flues by the electric butt welding process is indicated by the published report of the Master Boiler Makers' Association Committee on Welding Safe Ends. According to that report the Norfolk & Western now has in service about 280,960 tubes welded by this method, 152,000 of which were welded in 1919 with no failures reported. The Union Pacific was reported to be able to weld about 60 tubes per hour and to have more than 700,000 electric welded tubes in service with only two failures.

The practice on the Nashville, Chattanooga & St. Louis at Nashville shops is summarized in the following article which includes two illustrations, Fig. 1 showing the welding machine and flue roller and Fig. 2 being a plan of the flue shop with the movement of tubes and flues through the shop.

The process of electrically butt welding safe ends to all sizes of boiler tubes and flues has been used at Nashville since August, 1916, so that the results given were secured over an extended test period during which the electrically welded tubes and flues gave excellent service without failures. The type 40-A electric welding machine used is made by the Thomson Electric Welding Company, Lynn, Mass., and has a capacity of welding up to and including 5½ in. flues. The general principle of the machine is that heat is induced by passing a large volume of electric current at a low voltage through the butting tube and safe end to be welded, the heating effect being caused by the resistance of the metal to the flow of current. The greatest resistance to the flow of current is between the butting ends which therefore become hot first and when they reach the proper welding temperature, the current is turned off and pressure applied mechanically to force the molten ends together, thereby producing a weld.

The machine, shown in Fig. 1, was developed especially for welding boiler tubes and flues and its general construction is evident from the illustration. In the operation of welding, the tube is held in the clamp jaws or dies *A* which are forced together mechanically, clamping the tube and serving as one electrical contact. The safe end is similarly gripped in dies *B*. The electric current is turned on by means of a switch and the butting ends of the tube and safe end instantly begin to heat. The operator learns

to judge by experience when the welding temperature is reached and when the metal is hot enough, dies *A* and *B* are moved mechanically towards each other which forces the two molten ends of the tube and safe end together. At the same time the operator turns off the current, and the weld is made. The pressure on the dies is released, allowing the tube to be pushed through to rolls *C*.

Cost of Electric Welding

Extended experience has shown that the cost of electrically butt welding safe ends on 2-in. boiler tubes at Nashville is 3½ cents each, the time averaging about 1.12 min. each. This is the labor cost, and the cost for power, as determined by meter readings for a large number of welds is .224 cents for each 2-in. tube. The labor cost for safe ending a 5½-in. boiler flue is 15 cents, the time required 4 min. and the power cost 2.016 cents for each flue. One welder and one helper are necessary for the most efficient operation.

Referring to Fig. 1, the device for rolling the tube immediately after being welded is shown at *C*. The tube is pushed along on two supporting rolls as soon as the weld has been made and the welding dies release their grip on the tube. This arrangement saves practically one handling of the tubes and with a helper to facilitate handling tubes into the welder a considerable increase in production is obtained.

The method of handling tubes and flues through the shop at Nashville will probably be of interest and referring to Fig. 2 this movement will be readily understood. The tubes are cut from the boiler in the erecting shop, loaded on a truck and moved to the rattler *A* outside the shop. After being rattled a sufficient length of time to loosen and clean off the scale, the rack of tubes is moved into the shop by means of the flue rattler motor and stored on track *B*. When opportunity offers the tubes are then placed conveniently to the flue cutter *C* and the firebox ends cut smooth and square. An emery wheel is provided as shown for removing burrs. From bin *D* the set of tubes is moved to the electric butt welder *E* where they

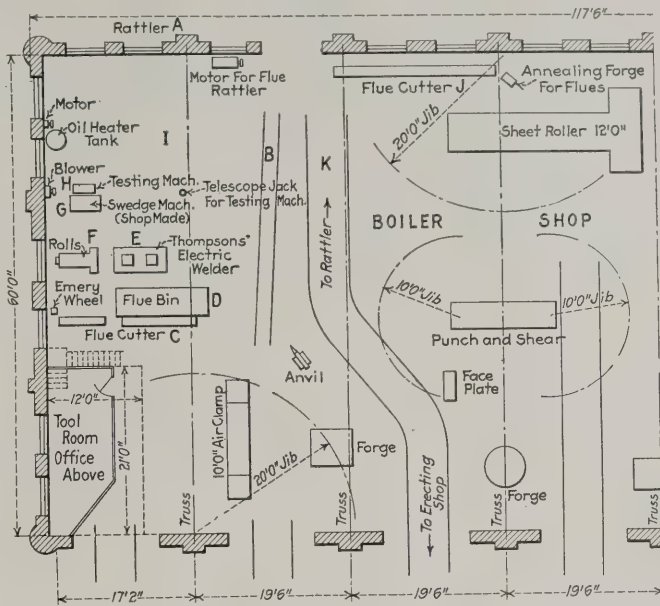


Fig. 2—Plan of Flue Shop and Course of Flues Through the Shop

are welded and rolled quickly with the expenditure of a minimum amount of time and effort.

The next operation is to swedge the tubes which is performed on a shop made machine. The tubes are tested and moved to *J* where they are cut for length and have the front ends annealed in the forge shown. The tubes are then ready for application to the boiler, being sent to the erecting shop along passageway *K*. The only back movement is from the rattler back to the first flue cutter, a condition which cannot be prevented in this case owing to the local shop lay out.

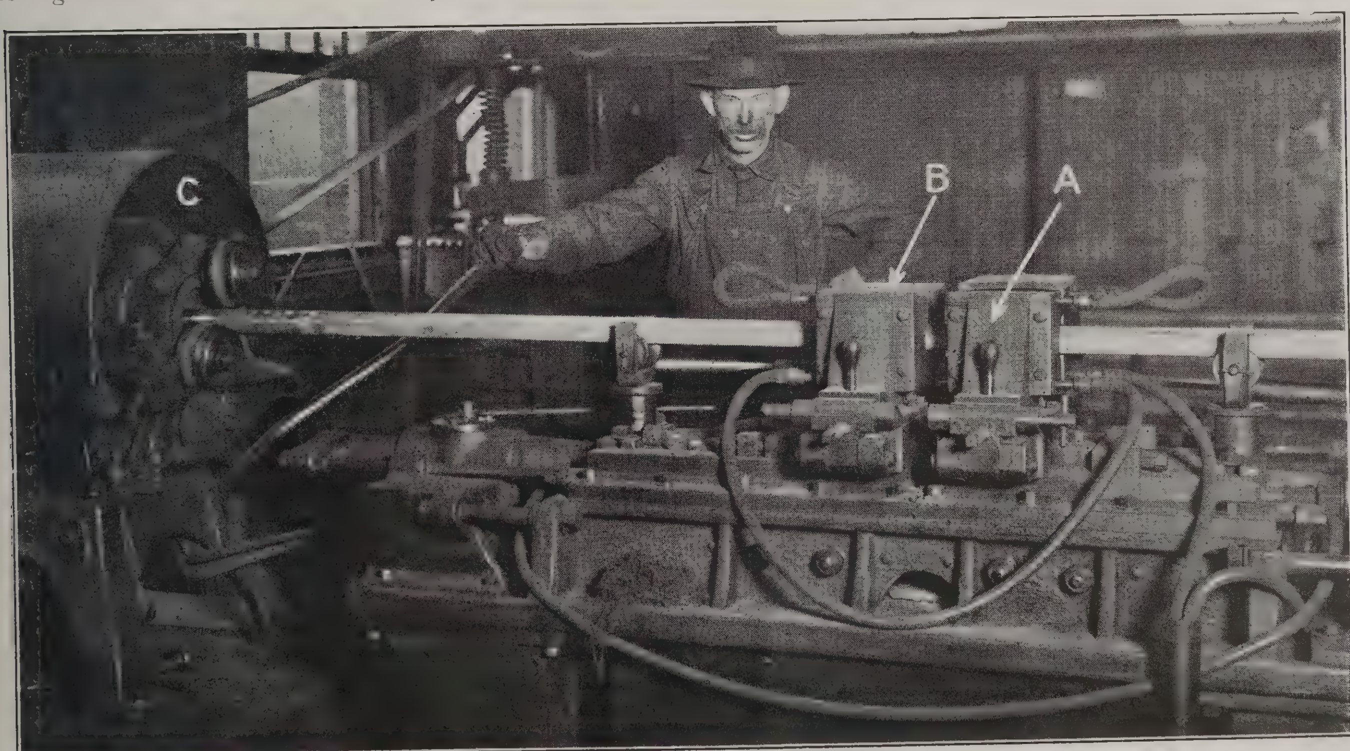
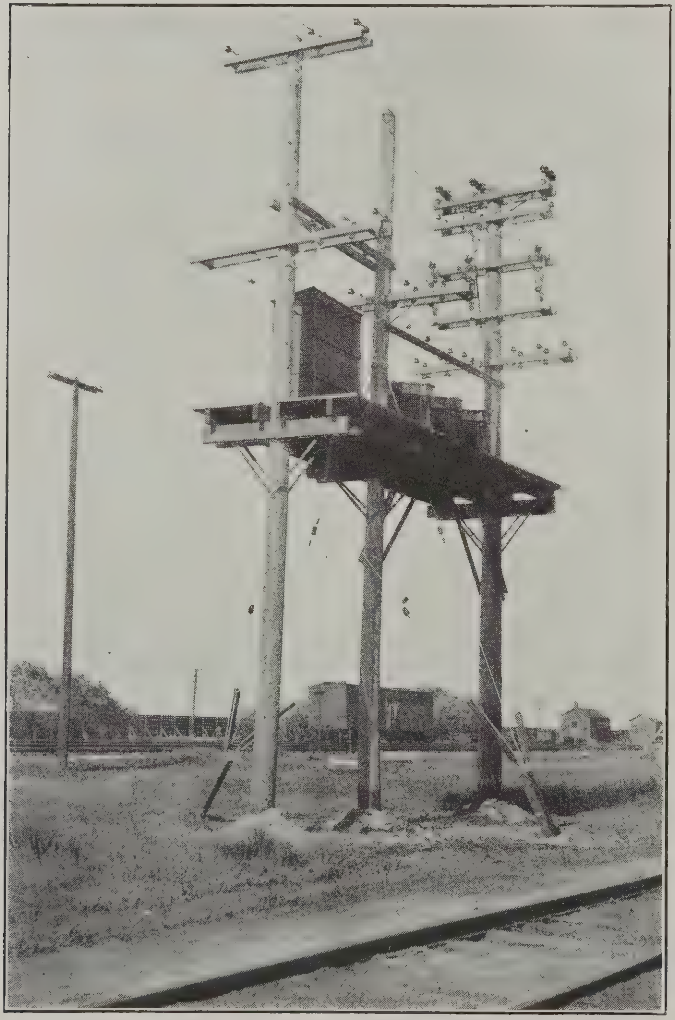


Fig. 1—Rolling a Boiler Tube After It Has Been Safe Ended in Thomson Electric Butt Welder

THE INTERCHANGE

A Novel Method of Raising Transformers

The practice of mounting service transformers on a platform between poles as shown in the illustration, is becoming a common one on many railroads. With the steadily increasing demand for electric power, the sizes of the transformers necessary have increased and it is not so often possible to mount two or three transformers on the cross-arms of a single pole. Also because of the increased weight of the transformers, it often happens that they cannot be raised with such blocks and tackle as the electrician can carry around with him.



Three 50 KVA Transformers Mounted on Platform

For this reason it is often convenient to call upon the services of a locomotive crane to place the transformers. Unfortunately, because of the height of the platform and because of the guying necessary, more than a simple crane operation is necessary. The platform is too high and is too far away from the crane to reach.

A method for overcoming this difficulty has been devised on a Western road. A fairly heavy pole, such as those on which the platform is mounted, is selected. One of the transformers is secured to the small end or top of the pole and the crane takes hold of the pole at a point at about one-third of its length from the top. The pole butt is then secured to the track with a light block and tackle and the pole and transformer picked up by the crane. In this manner the transformer is extended to a position which cannot be reached by the crane boom and by swinging the pole butt to one side and releasing on the blocks and lifting with the crane as necessary, the transformer is easily raised to position. The transformers shown in the illustration are rated at 50 kva. each and weigh 2,450 lb.

Failure

By W. H. H. MacKellar

What will you take for your failures, my man?
Make me a price, if you think that you can.
I'll buy the lot, if you sell them quite cheap.
Sort them all over and out of the heap,
Salvage the parts that are worthy of use,
And putting together the parts that I choose,
Show you, my friend, in a fortnight or less,
How out of a failure to build a success.

Failures have value, don't throw them away;
Remember that Rome was not built in a day.
Nothing was ever accomplished or done,
No mighty battle was ever yet won,
No great invention was ever yet made,
Nor yet the foundation of fortune well laid,
Unless in the building all progress and gain
Was based on a mixture of failure with brain.

When you come home from your work in the town,
Beaten by failure, and all battered down,
Don't be a quitter and give up the fight.
Go to bed calmly, and rest for the night,
Then up with the lark, and taking your cue
From yesterday's failure, go at it anew.
Sing while you work, and work while you sing,
And the chances are, man, you will master the thing.

Failure is only a big bugaboo,
Don't let it frighten a young man like you.
You're not the only good fellow to fail,
Others have done it, and they did not quail;
They stuck it out to the end of the game
And succeeded at last—so you do the same.
If Failure you capitalize, then my friend
Your efforts will bring you success in the end.

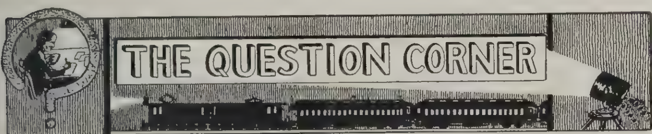
Helping the Locomotive

Workers in business organizations who kick, growl and make trouble for the management during the reconstruction days when managers of business everywhere have problems confronting them that require every bit of energy they possess, remind me of the green brakeman who was making his first trip up the Sierras.

The train was going up a very steep grade, and with unusual difficulty the engineer succeeded in reaching the top. At the station, looking out of his cab, the engineer saw the new brakeman and said with a sigh of relief: "I tell you what, my lad, we had a job to get up here, didn't we?"

"We certainly did," said the brakeman, "and if I hadn't put on the brakes, we'd have slipped back."

—*Tom Dreier, in Forbes Magazine.*



Answers to Last Month's Questions

1.—*What is the difference between one ampere hour and one watt hour?*

2.—*In a text book that I have, it is stated that connecting cells in series increase the current output, yet with gravity cells connected in series the current output is limited by the internal resistance to ¼ ampere. This does not seem to be an increase over the current of the individual cell. Does not the increased internal resistance of the cells in series neutralize the increase in current which might be available.* P. R. T.

* * *

1.—In answer to P. R. T., one ampere hour is 3600 coulombs. Coulombs = amperes × seconds. Therefore 1 amp. × 60 min. × 60 sec. = 3600 coulombs or 1 amp. hour. The watt hour is the amount of work done

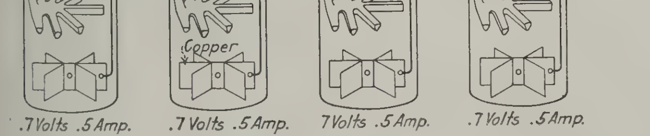


Fig. 1

by a current of one ampere flowing for one hour under a pressure of one volt, or 1 amp. × 1 volt × 1 hour = 1 watt hour.

2.—A series connection does not increase the current output of the cells. Cells connected in series increases the voltage, Fig. 1, that is, the voltage of the battery will equal the sum of the voltages of each cell. By connecting the cells in multiple the voltage of the battery is the same as that of a single cell, but the current is equal to the amperage of a single cell multiplied by the number of cells, Fig. 2. Of course; the more cells in

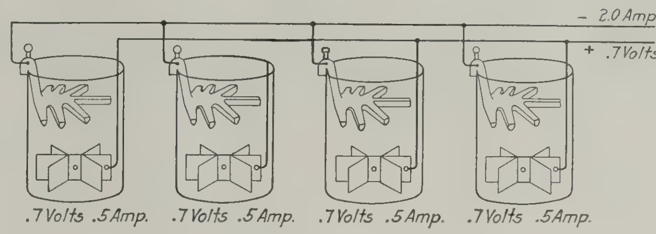


Fig. 2

series the larger the current that can flow through a given resistance, because of the larger pressure (volts) to force the current (amperes) through the resistance.

A. H. M.

* * *

1.—One ampere hour is the quantity of electricity which passes through a conductor during one hour when the current is one ampere. The quantity "ampere-hours" is the product of amperes and hours. Thus two amperes flowing for one-half hour would be one ampere-hour just the same as one-fourth ampere for four hours, etc.

One "watt-hour" is the quantity of electrical energy expended in a circuit when one watt (product of volts and amperes) is furnished for one hour. This is the product of pressure, current and time. The difference between ampere-hours and watt-hours is that the pressure or voltage of the voltage of the circuit is considered in the latter and is not in the former.

2.—It is true that the increase in internal resistance of cells in series neutralizes the increase in current that might be available up to a certain limit. This limit is determined by the design of the cell and the resistance of the external current. When the internal resistance of the cell is small compared with that of the external circuit, then this holds true, but would not in the case of short circuit or very low resistance. The resistance

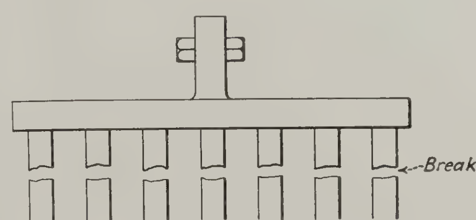
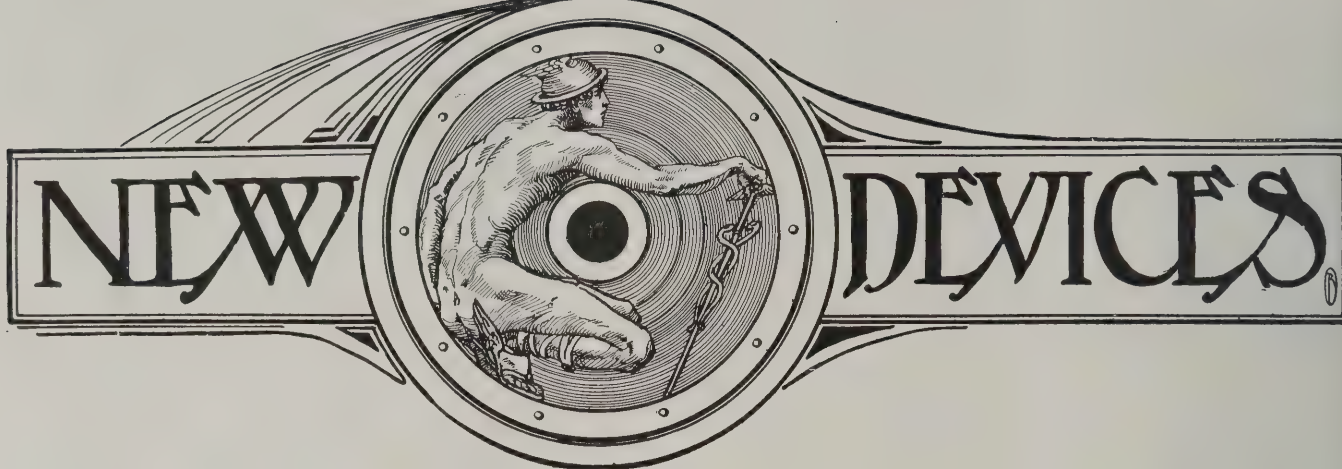


Fig. 3

of the gravity cell is comparatively high and connecting them in series on a circuit of very low resistance does not increase the current output of the battery.

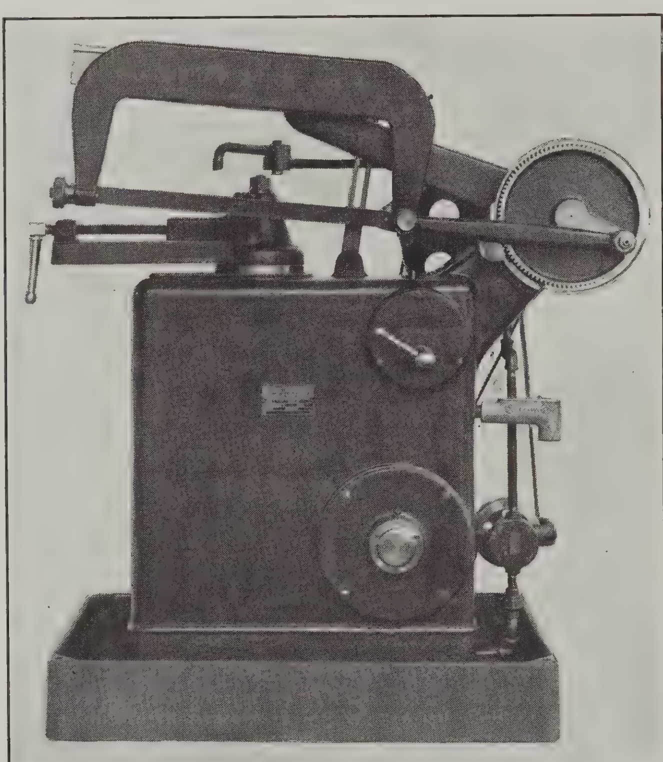
Questions for March

1.—*What would be the cause of plates of a storage battery breaking away from the connector straps as shown in Fig. 3? In the case on hand a Williard cell, 300 amp. hrs., gravity tested at 1180-voltage 1.9, plates broken away from negative strap; positive OK. Electrolyte normal height. Three cells in the same set went this way at different times.* A. H. M.



Self Contained Power Hack Saw

The electrically driven hack saw outfit shown in the illustration is unique in that the motor is housed in the base, thus making a compact self-contained unit which can be mounted on wheels if desired and

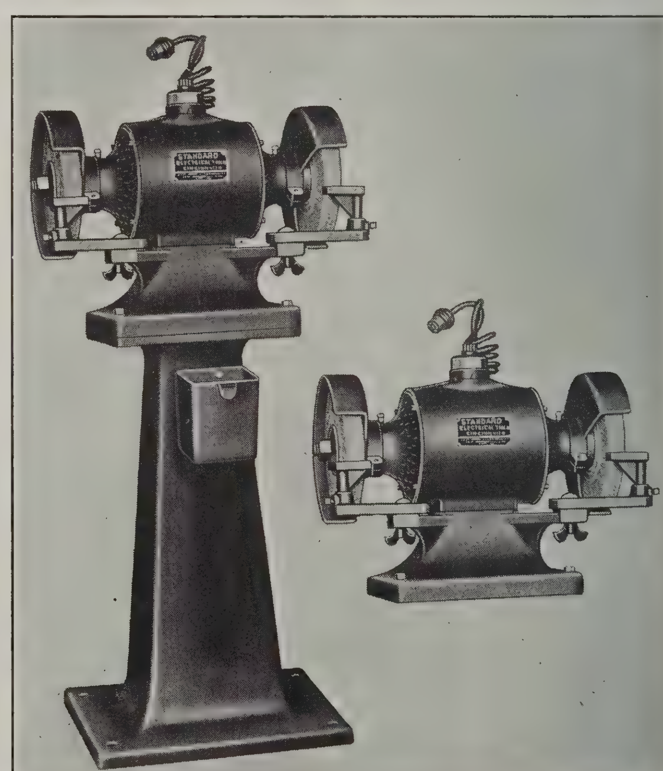


Portable Self-Contained Power Hack Saw

used as a portable machine. The motor and its control switches are built into the machine in such a manner as to be out of the way and at the same time protected from injury. The ½ hp. ball bearing motor used with the equipment may be had for any commercial voltage desired. The length of the saw used is 16 in. and the length of the stroke is adjustable between 5 and 7 in. The saw can be operated at either 45 or 90 strokes per minute so that hard or free cutting stock can be cut with best results. The saw can be raised and held in any position. The feed is by gravity and an automatic stop is arranged to stop the motor when the work is cut off. The saw slide is above the blade where cuttings and grit will not fall on the sliding surfaces. An oil pump may be used if desired. The vise swivels are graduated for cutting angles. The machine has a height of 36 in., occupies a floor space of 18 in. by 39 in. and weighs 450 lb. This hack saw outfit is being marketed by the Louisville Electric Mfg. Co., Louisville, Ky.

Bench and Floor Grinder

The illustrations show the improved type of ½ hp. alternating current portable electric grinder manufactured by the Standard Electric Tool Company,



Two Types of Grinding Machines

Cincinnati, Ohio. These grinders are fitted with high grade double-row ball bearings and the motor employed is manufactured by the Westinghouse Electric

& Manufacturing Company, being equipped with its latest improved type of circuit breaker.

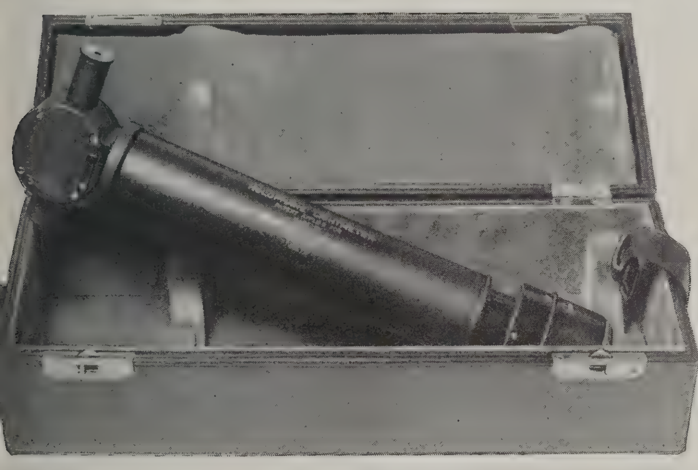
The tool is made in both the bench and floor types. It is for operation on alternating current and can be equipped for either 110 or 220 volt, single, two or three phase, whichever is specified. The wheels are 8 in. in diameter, ¾ in. face with a ⅝ in. hole. The grinding wheels are extended out from the body of the motor which permits grinding of long and irregular castings.

The floor type is fitted with water pot and both the bench and floor types have adjustable tool rests which makes them satisfactory for practically any class of work. One coarse and one fine wheel are regularly furnished with the machine. The coarse wheel is suitable for castings and rough work and the fine one is suitable for tools and fine work.

A quick make and break switch is located on top of the motor within easy reach of the operator. Ten feet of reinforced cord fitted with attachment plug is regularly furnished. Each grinder is guaranteed for one year both electrically and mechanically. The net weights are 110 lb. and 225 lb.

A Portable Lightmeter

A portable lightmeter for the purpose of measuring foot-candles, candles per square inch, candlepower, coefficients of reflection, etc., is being manufactured by the Keuffel & Esser Company, New York, and marketed by the Holophase Glass Company, New York. The lightmeter is made up of the following



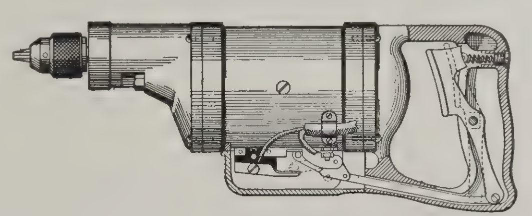
Portable Lightmeter and Case

parts: the photometric head, the lamp and battery with its housing, the rheostat, switch and mil-ammeter assembly.

The photometric head is an aluminum case containing a modified Lummer-Brodhun cube. Two concentric ellipses are viewed through the adjustable focus telescope. Light reflected from the test object passes directly through the telescope to the observer's eye, while the light from the standard lamp is reflected at right angles and passes through the telescope to the eye. The lamp used is a seasoned tungsten filament rated at 3.8 volts and 0.1 amp. It is operated at approximately 0.05 amp. in order to prolong its useful life. The yellow color which results from operating at reduced current is compensated for by a blue glass screen over the lamp housing. The rheostat, switch and mil-ammeter are arranged so that the switch and rheostat are operated by turning the mil-ammeter about its axis.

Improved Electric Drill

Patents have been applied for the electric drill shown in the illustration by the Jas. Clark, Jr., Electric Co., Louisville, Ky. The special features of this drill are the automatic switch located in the handle and the arrangement that places all of the electrical connections on the motor frame instead of having some of them in the



Side View of Clark Electric Drill With Handle Cut Away to Show Switch Mechanism

handle. The drill is made up of three sub-assemblies, namely, drill and drill spindle end with gears, the motor body, and the handle including the automatic switch. The drill is furnished in three sizes equipped with motors of 1/10, 1/8 and 1/5 hp., the complete drills weighing 11, 12 and 13 lb. respectively. The approximate speeds of the spindle in each type of drill are 1200, 900 and 750 r. p. m. The motors are designed for use on 110 or 220-volt alternating or direct current.

Edison Type Fuse Plug with Cartridge Refill

A refillable fuse plug of the Edison type with a cartridge refill is now being manufactured by the Cote Bros. Mfg. Corp., Chicago, Ill. It is simple and substantial in construction and is made in two parts; a body which is made of a heat-resisting molded insulation and con-

Fuse and the Two Parts of the Refillable Plug

tains the bottom contact of the fuse, and a cap which is made of molded insulation and a threaded brass sleeve. The fuse consists of a small cartridge fuse similar to those used on higher voltages. The fuse may be applied simply by dropping it into the hole in the body and screwing the two halves of the plug together. The size of the fuse is stamped on each end and is visible through a hole in the cap. The plug is designed for use on 125-volt circuits and refills are furnished in sizes ranging from 3 to 30 amperes.

General News Section

The Superpower system will be the subject of a paper presented in two parts by Henry Flood, Jr., and L. E. Imlay, at the spring convention of the American Institute of Electrical Engineers, to be held at the Drake Hotel, Chicago, April 19-21, 1922.

A Reuter cable states that plans for railway electrification in Czecho-Slovakia extend over a period of 20 years. A great saving in coal is expected. The first lines to be electrified are those converging on Prague with a radius of 30 miles in order to avoid the transport of coal to the capital.

William McClellan, president of the American Institute of Electrical Engineers, has announced the incorporation of the firm of McClellan & Junkersfeld, with temporary offices at 141 Broadway, New York. The work of the new organization will be on power plants, transmission systems, water power developments, electrification of railroads and general industrial and utility engineering and construction.

The number of automatic train stops in use in and around New York City, mainly in subways, aggregates about 3,700, divided as follows:

Brooklyn Rapid Transit Company (including New York Municipal Railways) 1,077, divided as follows: General Railway Signal Company, electric motor apparatus, 950; Federal Signal Company, electric motor 19 and electro-pneumatic 68; Union Switch & Signal Company, electro-pneumatic 40.

Hudson & Manhattan, electro-pneumatic, 244.

Interborough Rapid Transit Company, electro-pneumatic, 2,355.

To these must be added a small number, about 20, Hill automatic stops, in use on the Pennsylvania at its tunnels under the East and North rivers and at the drawbridge between New York and Manhattan Transfer.

No Particular Type of Train Control Endorsed by I. C. C.

The Interstate Commerce Commission has issued a memorandum to the press, referring to its automatic train control order, saying: "It has come to the commission's notice that parties interested in particular devices, by advertisements and other representations in stock—selling activities, are giving the impression to the public that the commission approved, and ordered carriers to install, their particular devices.

"The commission desires it to be understood that its order does not prescribe, prefer, or indorse any particular device or type to be used by any carrier.

The only requirement is that installation shall pass certain technical specifications and requirements which have been found to be necessary for the successful operation of devices of this character. These are so broad as to afford the desired freest field of opportunity for inventors and for trying out all automatic train control and train stop devices."

Demonstration of Regan Train Control

An operating demonstration of the Regan Automatic Train Control system of the intermittent electrical contact type as installed on the main line of the Chicago, Rock Island & Pacific between Blue Island and Joliet was made on February 13 for the benefit of railroad officers representing all departments which will be affected by train control installations. Speed control was demonstrated in connection with caution signal indications and the train was stopped automatically at locations where the signals indicated stop. On the return trip another locomotive equipped with the indication type of apparatus demonstrated the action of this type at four locations between Blue Island and Chicago.

Brighton Railway Electrification

The London, Brighton & South Coast Railway, England, has deposited a bill in Parliament to raise additional money for the purpose of electrifying certain portions of its line. It is estimated that the work will require an expenditure of upwards of £1,000,000 (or about $4,866,000 at the normal rate of exchange). The bill proposes to empower the company to borrow £500,000 ($2,433,000) authorized in the year 1911, and also further powers to borrow £1,000,000 ($4,866,000) which "may be raised without reference to the issue of any additional capital."

Committee to Study Train Control

Representatives of all but three or four of the 49 railroads cited in the Interstate Commerce Commission's proposed train control order met in Chicago on Tuesday, February 14, to consider the action to be taken in response to the Commission's order. At this time it was decided to create a committee of nine members to represent the roads with the understanding that any carrier may supplement such presentation in any manner and to such an extent as it considers necessary. This committee includes C. E. Denney, vice-president and general manager of the New York, Chicago & St. Louis, chairman; T. H. Beacom, vice-president and general manager, Chicago, Rock Island & Pacific; W. M. Jeffers, general manager, Union Pacific; A. M. Burt, assistant to operating vice-president, Northern Pacific; E. B. Katte, chief engineer electric traction, New York Central; C. H. Morrison, signal engineer, New York, New Haven & Hartford; W. J. Eck, signal and electrical superintendent, Southern Railway; R. W. Bell, general superintendent motive power, Illinois Central, and C. F. Giles, superintendent machinery, Louisville & Nashville.

It was also concluded that those roads which desire to show cause why this train control order should not be entered will appear individually before the Commission and that R. H. Aishton, president of the American Railway Association, should request the Commission to name a date on which this newly created committee may present its testimony in conection with the provisions of the order which affect all carriers.

Swedish Electric Locomotives for France

The Allmänna Svenska Elektriska Aktiebolaget—the well known "A. S. E. A."—has recently secured a contract from the French State Railways for construction of 30 electric locomotives at the company's works at Vasteras, according to information from Consul D. I. Murphy, at Stockholm.

Electrification of Italian Railways

The Italian ministry of public works has approved the electrification of the Bologna-Venice-Monfalcone line and the work is to be given to private industry. The Italian State Railway Administration is at present considering the question of using thermo-electric centers instead of hydro-electric centers, since the latter presents the difficulty of high cost of labor and materials and owing to the shortage of water supply with which Italy is at present confronted. It is reported that the electrification of the Chiasso-Bellinzona and Arth-Goldan-Luccona lines will be completed shortly.

Britain Lands South African Electrification Contract

Cable Advices from Commercial Attaché Walter S. Tower, of London, announce that the contract for electrification of 170 miles of single track of the South African Railway between Pietermaritzburg and Glencoe has been given to the Metropolitan Vickers Electric Company of Manchester. The cost of this work will be about 750,000 pounds sterling, being based on a revision of the British bids as of January 1. No new bids were asked for, since the old ones were reduced in amount on account of wage cuts in the electrical industry and other reductions in cost items.

Westinghouse Company Constructs High Voltage Transformer

A high voltage transformer capable of delivering one million volts above ground potential has been recently built and tested by the Westinghouse Electric & Manufacturing Company at its experimental laboratory at Trafford City, Pa. As long ago as 1913 the company in experimenting with high voltage produced a million volts, but these tests were accomplished by connecting two transformers in series, and grounding the connection between them and using the voltage between the line terminals. It is believed that the present transformer is the only single transformer ever successfully built and now in operation with one million volts above the ground potential. The product has some novel winding features which makes it especially well suited for high voltage work. The windings of this new transformer contain nearly 70 miles of wire and are assembled on the principle of a condenser bushing. The winding is divided into many cylindrical coils, each coil consisting of one layer of copper or turns wound on a micarta tube. The terminal bushing is the largest ever built in the Westinghouse shops and special machines had to be fitted to turn the bushing.

The Pullman System of Car Lighting

Ernest Lunn, chief electrician of the Pullman Company, presented a paper entitled "The Pullman System of Railway Car Lighting, Current Generation and Control," at a meeting of the Chicago section of the Illuminating Engineering Society, on February 23, at the rooms of the Western Society of Engineers, Chicago. Mr. Lunn described the axle generator equipment as applied to the Pullman car, explaining the method of operation by means of wiring diagrams drawn on the blackboard. He gave general descriptions of other systems in the same manner. Mr. Lunn's paper was followed by a general talk on the principles of illumination as applied to the interior of cars, covering such phases as the effect of surface treatment in the car interior, direct and indirect illumination, and methods of avoiding disagreeable effects from exposed filaments by the use of small shades or reflectors.

Electric Railway Construction in Norwav

Information from Christiania states that the Norwegian Storthing has granted a concession to A. S. Akersbanerne for the construction of an electric railway from the center of Christiania to Ostensjo, a distance of about 8 km. (5 miles). Work on this line will be commenced simultaneously with the construction of the Majorsteun-Sognsvandet Railway, a concession for which was also granted recently.

The Christiania Electric Tramway Company will soon begin construction on the extension of its Lilleaker line to Stabaek. This work will cover a distance of about 4 km. (2.5 miles).

Rock Island Electric Club

During the past month, meetings of the Rock Island Electric Club were held at Kansas City, Mo., and Horton, Kans. Mr. E. Wanamaker, Electrical Engineer, addressed the meeting at Kansas City, his subject being "What the Future Holds for the Railroad Electrician."

The subject was one of vital importance to those engaged in railroad electrical work and Mr. Wanamaker laid special stress on the increasing importance of the electrical equipment to the industry, illustrating how the operation of a large shop employing several hundred men could be stopped or production seriously retarded due to the failure or improper operation of some part of the electrical equipment. Every electrician, he said, should strive for a more complete knowledge of the different phases of his craft and not be content to merely understand "carlighting" or "headlighting," but to study the other lines of electrical work in order to eventually term himself a full fledged electrician.

Electrical Standardization in England

Owing to the inability of the companies which form the proposed Southern group of English railways, namely the London & South Western, the London, Brighton & South Coast and the South Eastern & Chatham to agree

to some form of uniformity in future plans for the electrification of these lines, the Minister of Transport has appointed a committee under an independent chairman to consider this matter. The committee consists of nominees of the respective companies under the chairmanship of Sir Philip Nash.

Personals

Stewart John Dewey, formerly assistant signal engineer of the C. C. C. & St. L. Railway, Cincinnati, joined the sales forces on March 1 of the Electric Storage Battery Co. Mr. Dewey has been assigned to the railway signal department, Chicago Branch. He will be particularly active in connection with the A. C. floating battery system, having been intimately associated with the first big installation of this system in the country, which is now being made on the Big Four.

Mr. Dewey brings a wide and varied experience in railway engineering work. He was born in Washington, D. C., in 1892, and was graduated from the Army and Navy Preparatory School of that city in 1910. In the same year, he entered the service of the C. H. & D. R. R., chief engineer's office, Cincinnati, O., taking up general railway maintenance and construction work. Later, in January, 1912, he resigned to enter the employ of the B. & O. R. R. of Cincinnati as draftsman in designing and estimating of railway structures. A few months later, he resigned the position to take up the duties of assistant division engineer at Saginaw, Mich., of the Pere Marquette R. R.

In January, 1913, Mr. Dewey entered the service of the C. C. C. & St. L. R. R. of Cincinnati as draftsman in designing and estimating of railway structures. In August of the same year, he was appointed assistant engineer in the construction department, having supervision of part of the reclamation work following the flood of 1913 and supervision of the construction of the White Water River bridge; also, designing and estimating of track elevation work.

In May of 1915, he was appointed assistant signal engineer of the C. C. C. & St. L. Railway, and continued in that capacity until he resigned to become associated with the Electric Storage Battery Co.

Obituary

Frank S. Dinsmore, who, for many years was connected with the Simmons-Boardman Company, publishers of the *Railway Electrical Engineer,* Railway Age and other transportation papers, died on February 14 at Brooklyn, N. Y.

Mr. Dinsmore's principal work was that of an advertising salesman; and therein lay the tangible measure of his pecuniary worth to the institution with which he was connected during the last twenty-four years of his life. But his employer values most what he did, by living example and fatherly advice, to help and encourage the younger men of the organization, both business and editorial. When discouraged, he lifted them from their depths; if he saw their jobs in jeopardy, he diplomatically and unobtrusively tried to awaken the sort of interest and ambition which would overcome the failing and when they required a guiding hand, it was his that was always outstretched. And with his tribute to Mr. Dinsmore's immeasurable worth his employer of the last 14 years unstintingly links his own sense of obligation for the unswerving loyalty and devotion that was reflected in so many varied and delightful ways. With employer and co-workers alike, Mr. Dinsmore's death has created a vacancy that is real. Everyone who was intimately acquainted with him will have as his most lasting impression the beautiful example his living afforded.

E. A. S.

Trade Publications

Sangamo Electric Company, Springfield, Ill., in its 4-page Bulletin No. 59 describes and illustrates the Brooks 2-stage current transformer. This type of transformer differs from the ordinary current transformer in that two cores are used and certain phase angle errors are corrected in the 2-stage design.

Generator Cooling Apparatus—The B. F. Sturtevant Company, Boston, Mass., has issued Bulletin No. 246, describing and illustrating in detail its generator cooling apparatus. A psychrometric diagram showing the percentage of relative humidity has also been included in the bulletin which contains 27 neatly arranged pages.

Sprague Electric Works, of the General Electric Company, in its Bulletin No. 48716 describes and illustrates the Sprague electric dynamometer. The machine described is used throughout the automotive industry, in government laboratories, and in scientific and technical schools is an important factor in reliable research.

Gasoline Power Units.—The Buda Company, Chicago, has issued bulletin No. 388, describing a four-cylinder gasoline power plant, which it has recently developed for use in driving electric generators, arc welding sets, triplex or other types of pumps, hoists, concrete mixers, air compressors and for similar uses in machine shops, etc.

Starting Small A C Motors is the title of a 16-page illustrated booklet recently issued by the Monitor Controller Company, Baltimore, Md. The bulletin is chiefly devoted to the description of the thermal relay and thermaload starters manufactured by the company. The pamphlet is well illustrated with photographs of the devices and their application.

Electric Engine Coalers—The Robert & Schaefer Company, Chicago, has just issued a four-page folder illustrating locomotive coaling equipment involving the use of an inclined elevator. The descriptions cover plants without elevated storage where the cars and the track hopper afford the storage, the coal being dumped directly from the elevating bucket into the locomotive tender.

Coaling Station Equipment—The Howlett Construction Company, Moline, Ill., has issued a 25-page, loose-leaf booklet, describing the types of coaling stations it erects, together with its line of coaling station equipment. This equipment consists principally of coal gates and aprons, electric hoists, hoisting buckets, car pullers, etc., all of which are illustrated by halftones and line drawings.

Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., has just published an illustrated folder No. 4475, containing a general discussion of the costs of Westinghouse lead base Babbitt metal. The publication describes the properties and application of the lead base Babbitt metal known as Westinghouse alloy No. 25, and genuine Babbitt, known as Westinghouse alloy No. 14.

Railway Electrical Engineer

Volume 13 APRIL, 1922 No. 4

Prosperity Is Here

The business depression which extended over 1921 and into 1922 has departed and all signs indicate that prosperity is here, even though some spots are as yet untouched by the revival of business. The railroads, impressed by the fact that they will have to handle a peak load during the summer months, are busy making such improvements as they can finance. The earnings so far this year have been fairly good and the managements appear to be more optimistic with the prospect of an early return to normal conditions in sight. Some indication of this spirit of optimism is reflected in the fact that although the roads only ordered 23,346 freight cars during the entire year 1921, they had ordered close to 50,000 such cars up to the middle of April. In like manner, while they ordered only 246 passenger cars for domestic use during 1921, more than 850 passenger cars had been ordered up to the middle of April this year. The situation as to locomotive orders is not so encouraging, although it is predicted that large orders will be placed later in the year. Meanwhile, many of the roads are going forward with more or less ambitious programs for the enlargement and extension of other facilities. In the past a movement toward the buying of railroad equipment has always been followed by a revival of general business. Business conditions have been improving slowly but steadily for several months. Let us hope that the buying movement started by the railroads is indicative of a complete and early return to normal conditions.

Light Electric Traction

Electric traction as applied to the railroads in the United States is generally considered as a major improvement that requires the expenditure of large amounts of money. Because of this fact little construction work of this kind has been done during the past few years when money was hard to get and railroad earnings were at low ebb. Electric traction has been in a condition of arrested development. As yet no new large contracts for electrification in this country have been let, although it is expected that some soon will be.

On the other hand, minor improvements are being made in branch line service. Many experiments have been made with gasoline motor cars on branch lines where traffic is light and the expense of operating trains for all classes of service may quickly eat up any possible small margin of profit. Exponents of electric operation have suggested recently that some form of light electric railway equipment could best meet these branch line service conditions. That, however, involves additional capital investment for trolley, substations and perhaps power stations. Under present conditions the railroads hesitate at the capital expenditures required for the purchase of gasoline motor cars, as they already have steam equipment that can handle the business. It may cost more to operate the steam train than it does the motor car, but they have the train and must buy the car.

In certain localities trolley service may be the best thing that could be chosen, but under the conditions that now exist, the motor car will probably receive more consideration. The motor car, however, need not necessarily be a gasoline car. Storage battery trucks in service on the highways and on city streets can be operated at a lower cost than gasoline driven trucks under many conditions. In branch line railroad service, where the total run is not too great, there are possibilities for the battery car. The regular schedules maintained in railroad service and the lesser vibration make the care of batteries easy as compared with those in trucks used on the streets. When motor cars are required, storage battery cars should be considered.

Testing Electrical Equipment

While the electrical departments of some roads are fairly well equipped to make more or less exhaustive tests of apparatus, there are many other roads where such work is restricted to a very limited amount, usually consisting of rough tests which fall short of giving complete information, oftentimes desirable. Unless the amount of testing to be done is large, it is not practical to invest in special testing equipment which, on account of its particular quality of preciseness, is always expensive. Complete information concerning the mechanical or electrical properties of different devices, while always desirable, is often not secured because of the expense involved in the purchase of special testing equipment. Complete testing is, nevertheless, a matter which should be given thorough consideration as often the knowledge gained therefrom may result in longer life and greater efficiency of apparatus in service. It is not necessary to forego the benefit of such investigation even though a road does not posses the necessary testing equipment. The services of testing laboratories are always available and at such places devices may be had for the most complete analysis of every operating condition. The cost of such testing may easily prove to be a very small factor and the knowledge gained can be made to react to show savings

in subsequent operation of electrical apparatus. In any event, the matter is deserving of consideration and should not be overlooked by the electrical engineer, especially in the purchase of new and untried types of equipment.

Save Your Copies

If you are interested in the subject of automatic train control, it will probably pay you to save your copies of the *Railway Electrical Engineer* beginning with the February, 1922, issue. All of the various systems which have been developed and are being tried out in railroad service will be described in this magazine for the particular benefit of the electrical men who will in part at least have to be responsible for the maintenance of the equipment that is placed on the locomotive.

The majority of railroad managements are apparently opposed to the adoption of automatic train control, but it has great possibilities and it is entirely possible that a number of roads will soon adopt it as an adjunct to, or in place of signals as used in automatic signal territory.

A large number of different systems of train control equipment have been developed, only a few of which will probably find their way into railroad service. Whether they are adopted or not they will be described in this magazine, and this series of descriptions will be a valuable record of the development of train control. As the articles deal especially with that part of the equipment that is mounted on the locomotive, those which describe devices that are adopted will be of particular value to men charged with their maintenance.

In addition to this, you have the advantage of the question and answer department. If the articles dealing with train control equipment do not tell you all you should know on the subject, mail your questions to the question and answer department.

Are Welded Flanges Dangerous?

The matter of applying welding processes to the repair of locomotive tires is one which warrants the most complete study and investigation. Long wheelbases and short radius curves result in the rapid wear of driving wheel flanges, causing one of the most troublesome problems with which the mechanical department has to deal. Locomotives that have been out of the shop less than four months often begin to cut flanges and in a short time the tire must be turned. This is done at considerable expense as the locomotive must be held out of service in the meantime.

It is quite possible to build up worn flanges by the gas welding process. This has been done on one road at least, and after two years of experience with the welding process, not a single defective flange has developed. The same work is performed on other roads by electric welding and a similar greatly increased total service mileage has resulted. It seems reasonable to assume that changes in the structure of the tire steel are more localized with electric than with gas welding, and the temperature at the point where the material is added is higher. Some claim that any such heating of tires changes the structure of the steel and is therefore dangerous.

In one extensive series of experiments results indicate that without subsequent heat treatment to bring tire steel back to its normal state, any method of fusion welding applied to steel tires changes their physical properties and is dangerous. The fact remains, however, that it has been tried and has proved to be successful notwithstanding the dangerous factor which some claim to be present. If the process of building up sharp flanges by fusion welding is safe, it presents great possibilities of economy, particularly where one tire of a set, almost down to the thickness limit, has a sharp flange.

In view of these conflicting opinions and practices, the subject of building up sharp flanges by the fusion welding process is apparently one which should come before the American Railway Association for proper consideration and report.

A Convention Opportunity

The business depression which acted as an effective obstacle to the holding of the semi-annual meeting of the Association of Railway Electrical Engineers last June and which also prevented the regular annual meeting of the association in October, is slowly but surely passing. Each day brings additional confirmation that business is becoming better.

Space for the exhibits of the Railway Supply Manufacturers' Association at Atlantic City in June in conjunction with the annual conventions of the Mechanical and the Purchases and Stores sections of the American Railway Association, is being rapidly taken up and the present indications are that the forthcoming exhibition will outrival any of those in the past.

For the electrical men there will be new developments among the exhibits that will prove well worth investigating. The man who neglects this opportunity to study and compare the various types of electrical equipment is not doing justice either to himself or to the company which employs him. By being fully informed in matters concerning his department he may easily be the means of saving thousands of dollars for the road which he represents.

The electrical activities on steam railways are extending into almost every department; it is natural that they should, for every additional application of electric energy spells efficiency and saving. Many of the matters in which the use of electric energy is involved are nominally in charge of the mechanical department. Unfortunately, in numerous instances this has resulted in suppression of activity on the part of electrical men. This condition cannot continue to exist, for as the use of electricity increases, the purchases of electrical equipment will be exceedingly large, and the responsibility will have to center in the man who has an intimate knowledge of the material purchased.

There is no better way to get at the ins and outs of any device than to have its manufacturer explain it to you, and there is no better opportunity to have so many devices explained to you as there will be at the Atlantic City convention and exhibit. If you have harbored any thought of not attending the June convention, dispel it. You cannot afford to stay away. You owe it to your company and to yourself to be there and to absorb all the information you can.

A 3,250-Ton Train on the Norfolk & Western Hauled by Two 11,000-Volt Alternating Current Locomotives

Effects of Electric Power Used for Traction

The Question of Inductive Interference and Electrolysis as Related to Railroad Electrification

By Prof. Chas. F. Scott

THE steam railroads of the United States are carefully studying improvements that will enable them to handle their traffic as soon as general business conditions reach a normal state. These investigations naturally bring the question of electrification into prominence and incidentally other problems related to electrical operation. In the past there has been considerable discussion of both inductive interference and electrolysis that may result from alternating current or direct current electrifications. It should be fully recognized that changes in the method of operating such extensive public utilities as the railroads are liable to cause disturbance in exposed circuits of communication companies, if no preventive measures are taken in the individual systems or their mutual relations. This has been the record of the past and the modifications introduced have generally resulted in the betterment of both services to the public, but a review of the past and present conditions shows that remarkable progress has been made in overcoming the difficulties encountered and that the conditions surrounding interference and electrolysis are now pretty well understood.

Telephone circuits are quite liable to induction from adjacent circuits unless suitable precautions or remedial measures are taken. A second telephone circuit causes cross-talk unless the wires are suitably transposed. Similarly, telephone circuits are liable to reproduce the clicks in nearby telegraph wires. The telephone has experienced some new trouble from each new kind of power circuit during the past 30 years; the direct current railway, arc lighting, alternating current transmission and alternating current railways have produced their own individual and particular problems. In a sense none of these problems have been solved as each condition constitutes a continuing problem; each new case as it arises may have special features calling for particular consideration.

A score of years ago the noise in telephone circuits having a single wire and ground return, which was caused by the ripples in the current to street cars, was taken to the courts for settlement. The telephone has changed its circuits, the complete metallic circuit is less susceptible to disturbances; the ripples in trolley current have been reduced and the engineering conferences have replaced controversy in court. The improvements have been progressive. Telephone circuits are better insulated; they are better balanced and transposed and changes in apparatus have been made. Power generators have been improved and power circuits are planned in various ways to lessen the amount of induction in parallel circuits. In spite of all these things there remains the inherent sensitivity of telephone circuits to interference rendering each installation a problem for specific consideration.

Difficulty With Early Electrifications

In recounting experience with specific electrifications, it will be found that great progress has been made in reducing interference incident both to direct current and to alternating current railways.

The New York, New Haven & Hartford was the first large alternating current electrification put into operation. A commercial telegraph line along the right-of-way requiring reconstruction in part on account of physical hazard was moved at a distance to avoid anticipated inductive interference. The induced voltages were very large but the railroad telegraph lines along the right-of-way continued in service by means of compensating transformers.

When the electrification was extended from Stamford

to New Haven the three-wire power system was devised and installed. In the change to the three-wire system on the original electrification, the existing trolleys and feeders were simply reconnected to balancing transformers. A very great reduction in inductive interference resulted, which is satisfactory to the telephone company and enables the railroad to operate its telegraph and telephone service in a cable along the railroad with drainage coils and without compensating transformers.

On the New Canaan branch of the New Haven system, where the conditions were peculiarly difficult, changes were made which reduced the very severe interference to the telephone when short circuits occurred on the railroad averaging a few times a month (at rare intervals occurring several times a day) to the point where there is little interference.

In the Paoli electrification of the Pennsylvania near Philadelphia, modifications in the power system and various measures taken in the telephone plant have very greatly reduced the ringing of the telephone bells and the breaking down of protectors when short circuits occur. In fact, it may be said that short circuits are now comparatively infrequent.

Another installation, the Norfolk & Western, installed nearly 10 years ago, where the heaviest train service in the world (considering weight of trains, grades and speed) is handled, has not produced serious inductions.

The latest alternating electrification, the Chestnut Hill branch of the Pennsylvania near Philadelphia, profiting by past experience and embodying the latest engineering, has not produced interference.

Summarizing on some of the single phase railways designed 15 years ago and 10 years ago, there were difficulties which have been greatly reduced or eliminated by changes in the power system and in the telephone apparatus; in the latest railway installed there has been no interference. This is a story of experience which gives good promise for the future.

It may be noted that the methods employed for obtaining this improved service are not revolutionary nor difficult of application, but are adaptations of well known appliances or methods to secure the desired results. The early plants were the first in a new field of operation. The data obtained in tests made after installation and under operating conditions in these plants enable calculations to be made beforehand and as a result of the experience thus gained, the handling of future installations is on a very different basis from that which obtained in the past. It may be noted, however, that the conditions which determine the amount and effective position of the railway return current which diverges from the track and flows through the earth are important factors. These are variable elements whose value in a particular locality can be accurately determined only by test. Favorable earth conditions due to networks of underground pipes may have been a contributing factor in the Chestnut Hill line. Although it is known that too high induction under ordinary operating conditions may cause interference with telegraph signals, a great many engineers have been surprised that the important problem in connection with alternating current railways is not avoidance of noise, but that the serious disturbances to the telephone occur only for the instant that high voltage is induced under emergency conditions such as short circuits. It is, therefore, important to consider the matter of short circuits and the methods of minimizing their effects.

A significant comparison has been made between the voltage induced in the telephone circuits by short circuits in an alternating current railway and in power circuits with solidly grounded neutral for a number of corresponding conditions believed to be such as might arise in practice. The disturbance in the telephone circuits was in all cases greater when caused by a power circuit than by a railway, ranging from an increase of 30 per cent to several hundred per cent.

The obvious conclusion is that power transmission circuits with solidly grounded neutral may be expected to produce telephone disturbances of the same kind and even of greater intensity than those caused by electric railways. The latter, however, may occur much more frequently as trolley lines supplying locomotives are more liable to accidental short circuit than transmission lines supplying substations.

Comparison Between Alternating and Direct Current Railways

(a) Noise during normal operation.—On the alternating current railroads referred to noise has not been a factor of any consequence, but on the Chicago, Milwaukee & St Paul, the outstanding direct current electrification, the noise conditions under normal operation were such as to require a remedy which was found by a change in generator construction and the installation of resonant shunts. Staggering of armature slots in generators is a valuable method of reducing noise, but with the earlier designs of machines it has not been sufficient.

(b) Effect of ground potential under normal load conditions.—No interference has been experienced in connection with a. c. railways, separable in effect from induced alternating voltages, but interference with grounded telegraph or other types of grounded signaling may occur due to difference of direct ground potential in d. c. railways. The difference in ground potentials incident to a 3000-volt installation may far exceed those caused by a 600-volt system.

(c) Magnetization of loading coils at a time of short circuit.—No experience is recorded of difficulty caused by magnetization of telephone loading coils in the many years of a. c. operation which is known to be the result of short circuits.

In connection with d. c. operation it has been pointed out that under certain circumstances magnetization may be expected from theoretical consideration.

(d) Trolley short circuit conditions.—The greatest problem in telephone interference from alternating current railways occurs at the time of the momentary maximum current or short circuit. The principal effect is the breakdown of telephone protective devices which may result in acoustic shock. If the conditions are made such that the induced voltage caused by short circuit is within proper limits the conditions under normal operation will in general be quite satisfactory.

Under short circuit conditions on d. c. railroads, tests have shown that telephone protectors may be grounded by the action of the momentary induced voltages and that light acoustic shocks may be experienced by persons listening on nearby parallel telephone circuits.

Comparison between the effects of a. c. and d. c. short

circuits shows that the effects of short circuit surges will be less severe with a high voltage d. c. system than with an a. c. system. While there may not be large differences in the peak voltages induced in the two cases, the amount of energy transferred to the communication circuits will be greater in the a. c. case due to the longer duration of the short circuit condition, since the initial transient is followed by several cycles of short circuit current. In the d. c. case, there is only the brief initial surge followed as a rule by a smaller voltage of still shorter duration in the reverse direction, and, as experience shows, the effect is comparatively small.

Hence the peak voltages (which may be substantially of the same magnitude) produce different effects because the d. c. continue for only .01 or .02 of a second, while the a. c. is followed by several cycles of short circuit current. If, then, there were a quick acting a. c. circuit breaker which would operate in half or three quarters of a cycle, the short circuit would continue for only .02 or .03 of a second, and the energy transferred to the communication circuit would be comparable to that caused by d. c.

The remedy for serious inductive interference when short circuit occurs may, therefore, be anticipated in a quick acting circuit breaker for alternating current. Such a breaker is now being designed and its successful completion will enable the effects of short circuits to be very greatly reduced.

(e) Transmission line conditions.—In case either a. c. or d. c. electrifications, there will be alternating current transmission lines for supplying power to the substations. The transmission lines of 60 cycles for supplying the direct current trolley system give rise to inductive interference which is greater than when caused by a. c. transmission lines of 25 cycles serving the a. c. trolley system. On the St. Paul direct current trolley system the transmission line abnormals necessitated a remedial measure, loud speakers replaced the usual receivers on the dispatching telephone circuits. A comparison of a. c. and d. c. systems should consider all factors including the transmission line for supplying the substations.

(f) Location and character of specific electrification.—The New Haven four-tracked electrification handles heavy traffic through a succession of towns and cities. The Paoli four-track and Chestnut Hill double-track branches of the Pennsylvania provide frequent service to the suburbs of Philadelphia. These alternating current railroads pass through highly congested districts where the effects of interference are liable to be much more serious than elsewhere.

The C. M. & St. P. direct current has occasional trains on a single track road extending many hundred miles through the mountains and a sparsely settled country.

The conditions are not comparable. If the initial direct current 3000-volt electrifications had been called upon to meet the New Haven or Pennsylvania requirements, the experience with direct current operation would have been quite different from that recorded for the C. M. & St. P. or the experimental line at Erie, on which the maximum distance for which tests are recorded is 1.8 miles.

The Telephone Circuit.

It has been customary to classify as incident to interference with communication system a long list of possibilities. It does not appear that certain of these possibilities have rarely, if ever, been realized; for example, magnetization of loading coils, and the breakdown of the insulation of cables or of interior equipment, such as coils, condensers and associated wiring. Nor is there any statement that the overheating of apparatus or a fire hazard are other than apprehensions after many years of experience. They must all, however, be classed as possibilities, although they may never have occurred by induction from railways. Some of these phenomena have to be caused by induction from power transmission circuits.

The purpose of the protector (which places short air gaps between each wire and ground) is to form a ready path for high voltages to pass to earth, thus protecting the telephone. The protection, however, is not ideally perfect as high voltages, such as may be caused by lightning or short circuits in parallel electric circuits, may cause acoustic shock. The conditions are delicate and exacting so that improvements are difficult. But an ideal protector would go far to reduce the effect of short circuits, just as an ideal line insulator would go far to prevent short circuits. Ideal perfection in each seems remote, but improvements are much to be desired.

It is generally recognized that precautions must be taken in the layout of both a.c. and d.c. electrifications to avoid interference that will affect the service given by telephone systems. On the whole, the d.c. has an advantage over the a.c. from the standpoint of interference, but in planning either a d.c. or an a.c. electrification, special precautions must be taken. The precautions may involve special features in the electrification plans.

In both systems of electrification supplementary measures must be taken in the layout of the communication circuits as well and every effort made to maintain first class conditions in the telephone systems. Generally, comparisons that have been made of the relative modifications necessary on electrifications have not been on systems having similar service conditions. While it is recognized that modifications are necessary, definite estimates should be the basis of decision rather than general indefinite assumptions as to complication and expense of some particular feature. Judgment as to the merit of a particular project should be left until the final plans and estimates are completed.

Electrolysis.

The effects of corrosion by the alternating current under ordinary conditions of practice may be considered negligible.

The well-known electrolytic action of 600-volt street railways occurs also with high voltage systems. The "high voltage," however, implies less current and hence less electrolysis for the same power delivered. Furthermore, much of the mileage of a high voltage railway is presumably in the country where underground pipes are few. These features obviously render the electrolytic problem less serious than it would be if the voltage were lower and there were pipes along the right-of-way.

On the other hand, the power and the current taken by heavy trains reach large figures, and the railways have city terminals and in some cities there is large mileage in the city districts. Chicago, for example, has several thousand miles. Precautions may be taken by arranging short feeding distances, but this implies additional sub-stations

and sub-stations with 3000-volt motor-generator sets and usually with expert attendance tend to increase cost. Substations will necessarily be needed near city passenger terminals and freight yards where heavy currents for starting trains are needed. The corrosion of pipes said to have occurred in the pipe near substations along the Milwaukee 3000-volt railway, indicate conditions which may have far more serious results when the substations are in large cities unless suitable precautionary measures are taken. These should be provided and their cost considered on the same basis as measures to obviate inductive interference in the a.c. system.

Summary.

The following specific statements regarding inductive interference, and the electrolysis by alternating current railways, supplement the preceding general discussion and the comparison between the effects caused by direct current and by alternating current railways.

1—*Inductive Interference.*—The problems involved are complex, but the conditions are pretty well understood so that provision can be made for mitigating disturbances. In alternating current electrification, great progress has been made in handling inductive interference. Theory and the experience gained on several roads under different conditions have been continuously contributing to the solution of the problem. The latest installation has produced no interference. Certain changes in alternating current railway equipment and in telephone equipment will go far to avoid difficulties elsewhere.

In direct current high voltage electrification, the experience is practically limited to one system. It is stated that the difficulties there encountered have been overcome by changes in generators and by the addition of the resonant shunts.

Although in both alternating and direct current electrification the general causes and conditions are known, it is important to determine what measures should be taken to meet the particular situation in each case. The problem is to determine the best solution. It may call for modifications in the railway system, or in the telephone system, or in both. Determination of the course to be taken should, as far as practicable, be made before installation and should be such as to involve the least total cost for proper rendering of both services.

Electrolysis.—The effects of corrosion by alternating currents under ordinary conditions of practice may be regarded as negligible.

Direct current railways, whether at high or low voltage, have the same inherent tendency to corrosion on underground metal by electrolysis. The same kind of remedial measures which are employed in connection with street railways are applicable to the high voltage systems. The cost should be included as a part of the cost of the electrification.

It is generally agreed that inductive interference and electrolysis are matters which should be taken into consideration when an electrification is being planned; that provision be made to prevent difficulties; that the plan should, on general principles, be that which is cheapest, whether this means special arrangements in the power system or in the telephone system, or separation of the two, the plan in a particular case being that which will involve minimum cost.

Communication With Moving Trains

EXPERIMENTS the again being made on the Delaware, Lackawanna & Western with radio telephony and telegraphy as a means of communication between a moving train and established radio stations. At the present time a car running between the Lackawanna terminal, Hoboken, N. J., and South Orange, N. J., has been equipped with several different types of receiving apparatus and a sending outfit. Among the different types of equipment being tried is the super-heperodyne outfit which was used for receiving messages in Scotland from amateur radio operators in the United States. The transatlantic tests were made in December, 1921.

So far, operations on the Lackawanna have been limited to communication between a train running at full speed with amateur radio stations within a radius of 30 miles and with some of the large broadcasting stations at distances considerably in excess of 100 miles.

Photo by Kadel & Herbert.

Radio Equipment in Operation on Car

Wider possibilities have been opened by recent developments in radio equipment. Radio stations can be connected with ordinary telephone circuits, and with radio stations located at intervals along the right-of-way, it should be possible for a person on a moving train to communicate with any point reached by regular telephone service.

In connection with proposals to electrify the Temiskaming & Northern Ontario Railway and its branches, either as a whole or in part, the company's commission has authorized S. B. Clement, chief engineer, and J. G. Kerry, consulting engineers, to report as to the power possibilities along the route, the power requirements for operation, and the general feasibility of electrification. A report, says the Canadian Railway and Marine World, is to be ready about the end of March.

There are some very extensive water powers on the Abitibi River, which can be reached for development with the completion of the extension of the Temiskaming & Northern Ontario Railway from Cochrane for 70 miles northwesterly, for which tenders have been asked. It is estimated that approximately 300,000 hp. can be developed at two of the falls alone.

Regan Automatic Train Control System

A Description of the Contact Shoe and Ramp Type —Inductive Apparatus Has Also Been Developed

THE Regan intermittent electrical contact type of automatic train control consists of two elements: one comprising the locomotive and tender equipment and the other apparatus located on the roadside. The locomotive equipment for automatic stop only includes an electro-pneumatic valve, shoe mechanism, battery and release key. When a combination of automatic stop and speed control is used, then the locomotive equipment includes, in addition to the above, a speed controller and a relay. Visual or audible cab signs may be included when desired. The illustration, Fig. 1, is typical of the arrangement as installed on locomotives of the Chicago, Rock Island & Pacific Ry. The roadside equipment consists of a specially designed ramp, a battery, a relay and the necessary connections into the signal system. The illustration, Fig. 2, shows the ramp as installed on the Rock Island.

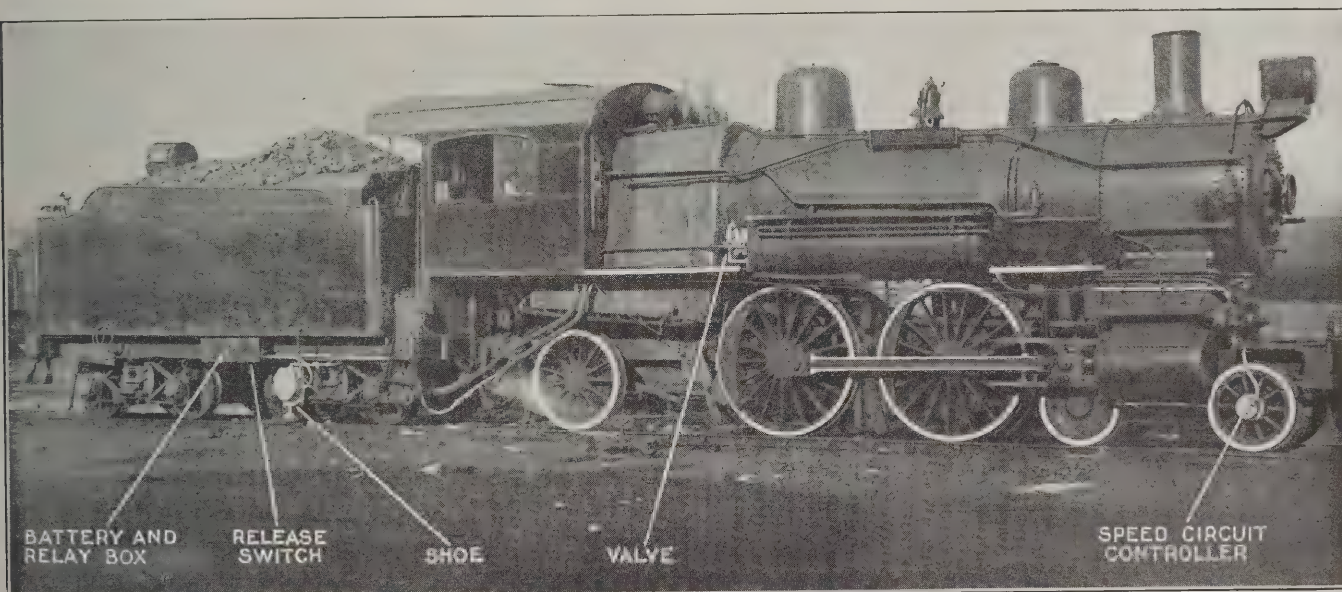


Fig. 1—Typical Arrangement of Apparatus

Various Arrangements

The system provides for the following arrangements and combinations of automatic train control:

(1) Automatic Stop Only.

(2) Automatic Stop with Low Speed Control.

(3) Automatic Train Control with Medium Speed Control.

(4) Automatic Train Control with Medium and Low Speed Control.

Shoe Mechanism

The shoe mechanism is contained in a steel housing secured to a bracket, which is rigidly fastened to the tender truck frame or to some other suitable place on the locomotive. In this shoe mechanism there is a cast iron stem which is operated from brake pipe air pressure contained in a cylinder at the top of the stem. The arrangement is such that in case the shoe stem is broken off by contact with an obstruction, the brake pipe air pressure is reduced to apply the brakes through an opening to atmosphere, created in the shoe stem when the breakage occurs. A bracket, fastened to the shoe stem, supports a circuit controller for changing the engine relay circuits from the engine battery to the roadside battery whenever the shoe rides over an indicating ramp; that is, when the shoe rides over the ramp the only source of energy for maintaining or changing the indication on the engine is that obtained from the roadside circuits, and as the shoe rides down the leaving end of the ramp, the shoe mechanism circuit controller again changes the circuits so that the source of energy for maintaining the indication received is then transferred to the locomotive battery.

The shoe stem is held in position for contact with the ramp by means of brake pipe air pressure; this forces the shoe stem down and gives sufficient contact pressure when riding over the ramp. When the shoe stem is secured in the "up" position, the locomotive circuit is de-energized, thus conserving energy from the storage battery.

Speed Controller

The speed controller mechanism is housed in a weatherproof case directly attached to the front wheel and axle of the pony truck. It consists of two parts: one which revolves with the axle to which it is connected, and the other which remains stationary, being arranged for connection with the locomotive circuit by means of a substantial flexible conduit. Ball bearings are used to reduce the friction to a practical degree and to guard against undue strain on the flexible conduit. The housing is rigidly bolted to the end of the axle of the pony truck wheels and accurately centered by a projection from the housing, fitting in the counterbore in the axle. This speed con-

troller is of the centrifugal type and is provided with a spindle which forms the axis of the centrifuge arrangement. It operates in the horizontal position on the spindle. A crosshead, which is connected by links to the arms of the centrifuge, is free to move along the spindle. Fastened to the end of the crosshead and insulated therefrom, is a contact button. Attached to the stationary part of the speed controller are electrical contact springs designed so as to contact with the contact button. As the locomotive accelerates or retards in speed, the crosshead moves back and forth on the spindle, causing the contact button to break or make the electrical circuits connected through the contact springs. A compression spring is used to keep the crosshead in the extended position, thus opposing the force of the centrifuge when the locomotive is moving. The tension in the compression spring is adjustable to the speed at which it is desired the electrical contacts should make and break.

The Electro-Pneumatic Valve

The electro-pneumatic reservoir and brake pipe valve shown diagrammatically in Fig. 5 and illustrated in Fig.

Fig. 2—Ramp Located on Roadside

4 is of the diaphragm type. This valve is connected in the main reservoir pipe at the openings 6 and 7. A branch from the brake pipe connects to opening 5.

In the lower part of Fig. 5 is a stem *D*, rigidly connected to the armature of the magnet, being in an "up" position when the magnet is energized and "down" when the magnet is de-energized. Pipe *15*, chamber *16* and channel *17* connect chamber *1* with chamber *18*, so that the air pressure in chamber *18* is the same as in chamber *1*. When magnet is energized stem *K* is lifted, admitting air to primary valve from chamber *18* to chamber *3*, via channels *19*, *20* and *21*. With air at pressure in chamber *3*, the lower diaphragm is extended upward, causing valve opening *28* to be closed by valve *G* and valve *F* to be unseated from opening *29*. These valves being connected by stem *22* (the position shown is that existing normally and the one just described).

When magnet is de-energized, primary valve stem *K* is closed on seat *L* at the top, so that air cannot pass into channels *19*, *20* and *21*, leading to chamber *3* from chambe *18*. Simultaneously, primary valve stem *K* is open at the bottom seat L_1, permitting the air at pressure in chamber *3* to flow to atmosphere via channels *21*, *20*, *19*, chamber *23* and channels *24*. With chamber *3* freely opened to atmosphere the air at pressure in chamber *1* on top of valve *F*, in chamber *2* on top of upper diaphragm *H* and in chamber *4* through port *28* on top of valve *G*, together with the force of gravity forced downward, stem *22*, to

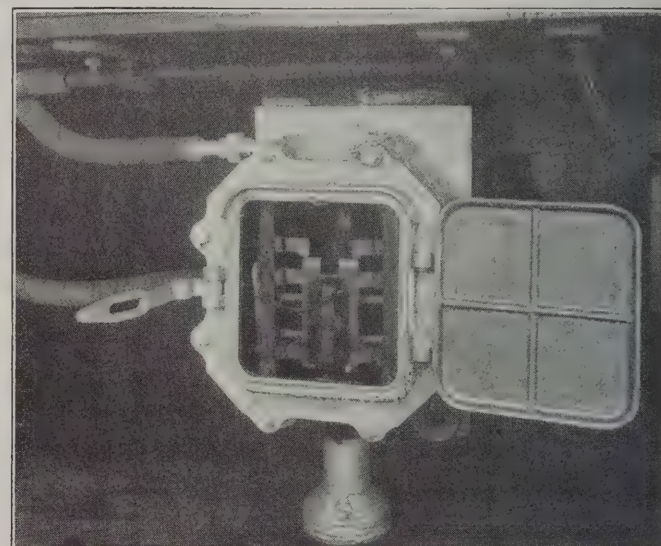


Fig. 3—Contact Shoe With Door Open

which valve *F* and *G* are connected, so that valve *F* is seated, cutting off flow of air from opening *6* to opening *7*, and valve *G* is opened, permitting a free passage of air to atmosphere via opening *5*, chamber *4*, port *28*, chamber *25*, channels *26* and port *27* in vent plug *C*. The air is restricted in its outlet to atmosphere by the ports in exhaust vents *Z*. These ports are of a size to

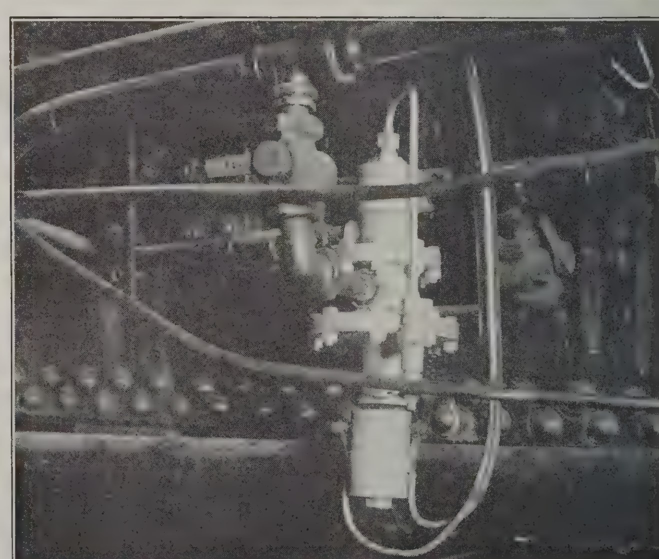


Fig. 4—Reservoir and Brake Applied to Engine

give the proper brake application. There is no free passage for air between chambers *2* and *4*. A strainer *M* is placed in chamber *16* in such a manner as to catch any dirt or moisture from the air line if any should be present, causing it to fall into the chamber of air cock *U*, where it can be expelled from the system.

Typical Locomotive and Ramp Circuits

The circuit, Fig. 6, for automatic train control is based on its use with a three-position signal system, having a polarized control line circuit. The train control system is controlled by relay B insofar as wayside indications are concerned.

Normally the ramp is energized through the following circuit: 16 cell battery, positive pole, wire D3 and D2, polarized and neutral contacts of relay B, wire 100, ramp,

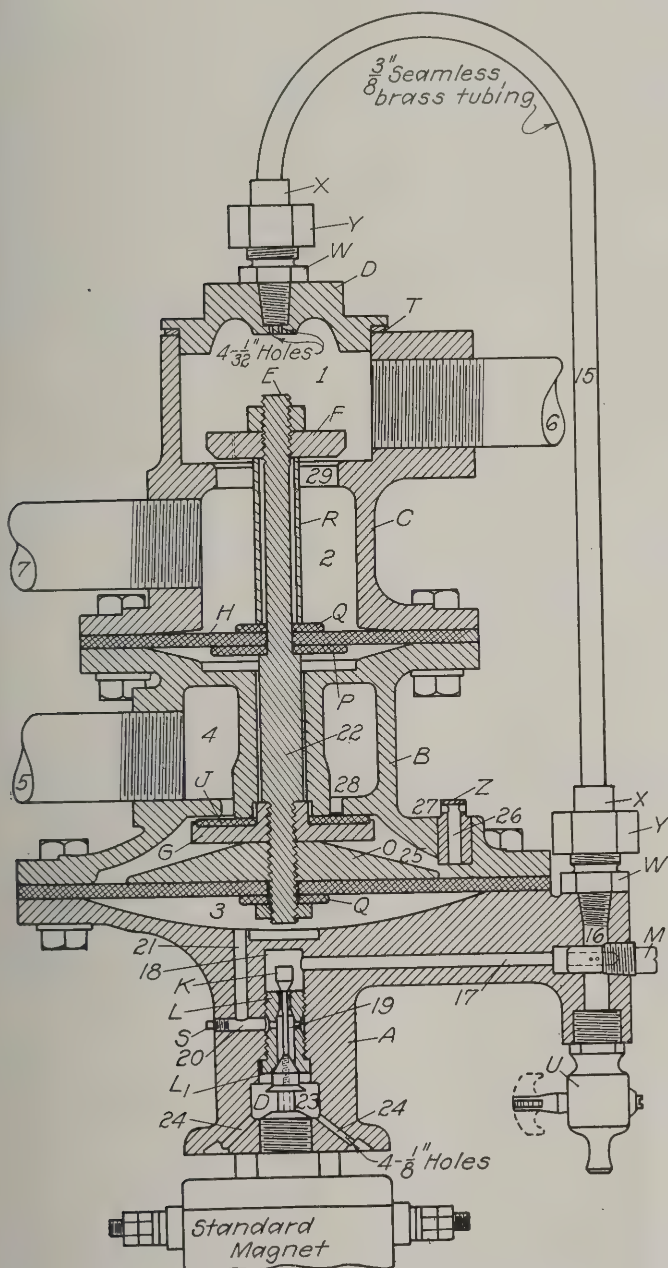


Fig. 5—Diaphragm Type Reservoir and Brake Valve

wire 105, present railway company signal line relay, wire 106, neutral and polarized contacts of relay B to negative pole 16 cell battery. This circuit as described is primarily for checking the integrity of the ramp. Anything happening in it to de-energize relay A will cause the signal at this location to indicate stop and the signal in the rear to indicate caution.

That part of the ramp circuit co-operating with the locomotive when it passes over the ramp is as follows: Wire 107, connecting to track rail P, circuit controller on signal, wire 108, resistance, wire 109, polarized contact of relay B, 16 cell battery, polarized and neutral contacts of relay B and wire 100 to ramp.

Whenever the polarity to the control relay B is reversed, which is the condition when the signal indicates caution, then the polarized contacts of relay B are reversed as to position and the electrical energy of the ramp is reversed in polarity. When the signal is in the stop position, relay B is de-energized so that the opening of its neutral contacts cuts energy off the ramp. In order that the ramp may not transmit energy to the locomotive apparatus, if the signal for any reason is at stop while the control circuit is intact, the ramp circuit is carried through a circuit controller attached to the signal and designed to be open when the signal is at stop.

Locomotive Circuits

Normally the locomotive circuit is furnished with electrical energy from a 10-volt storage battery on the locomotive. The circuit is as follows: Positive battery, contact 2 of the three-position relay, wire 3, contact 16 of shoe mechanism, wire 5, electro-magnets of neutral lock and three-position relay, wire 7, contact 10 of shoe mechanism, wire 11, contact 21 and wire 31 to negative side of 10-volt battery.

As shoe S′ rides the ramp, its stem operates a circuit controller connected to it, so that at first the upper contacts 18 and 14 are made, then contacts 10 and 16 are broken. When contacts 10 and 16 break the circuit of the three-position relay through the 10-volt battery on the locomotive is broken, which, unless the ramp is energized, causes the three-position relay to become de-energized and assume a neutral or de-energized position. However, when contacts 10 and 16 break, and while shoe rides ramp, providing ramp is energized as shown, the three-position relay will receive current through the following circuit: 16 cell battery, positive pole, wire D3, wire D2, polarized and neutral contacts of relay B, wire 100, ramp, shoe, wire 19, contact 18, wire 5, three-position relay and neutral lock coils, wire 7, contact 14, wire 43, frame of locomotive G, axle and wheels T, track rail P, wire 107, circuit controller on signal, wire 108, 4-ohm resistance unit, wire 109, polarized contacts of relay B, to negative pole of 16 cell battery. This retains the three-position relay in the normal energized position. As the shoe leaves the ramp, contacts 10 and 16 are first made, then contacts 14 and 18 break. As contacts 10 and 16 make, the three-position relay receives current from the engine battery and so continue after the shoe leaves the ramp. This is the case when conditions are right for the train to proceed at speed; that is, when the signal is clear. Assume a condition where the polarity on the ramp is reversed from that shown. When the shoe is on the ramp, with contacts 18 and 14 made and 10 and 16 broken, then the three-position relay receives current as follows: 16 cell battery, positive pole, wire D3, wire D4. polarized contacts of relay B reversed, wire 109, wire 108, circuit controller of signal, wire 107, track rail P, wheels and axles T, frame of locomotive G, wire 43, contact 14 of shoe mechanism, wire 7, neutral lock and three-position relay coils, wire 5, contact 18, wire 19, shoe, ramp, wire 100, neutral and polarized contacts of relay B reversed, to 16 cell battery negative pole.

This condition causes the three-position relay to assume the negative or reverse position so that contacts *20*, *21*, *27*, etc., are closed, instead of *2*, *12*, *26*, etc. As the shoe leaves the ramp, contacts *10* and *16* of the shoe mechanism are made and then contacts *18* and *14* are open, in which position they remain after the shoe leaves the ramp. The three-position relay also remains in the negative or reverse position. The following circuit under this condition is established: Locomotive battery, positive pole, resistance, wire *23*, contact *21*, wire *11*, contact *10*, wire *7*, neutral lock and three-position relay coils, wire *5*, contact *16*, wire *3*, contact *20*, wire *22* and *13* to locomotive battery, negative pole.

With no energy on the ramp another condition exists. As heretofore explained, contacts *18* and *14* are made and then contacts *10* and *16* are broken as the shoe rises on the ramp. The breaking of contacts *10* and *16* disconnects the locomotive battery from the three-position relay. As the three-position relay is de-energized, it assumes the third or de-energized position with no contacts (except special) closed and remains in this condition until some independent action as the operation of the release switch is taken.

The electro-pneumatic reservoir and brake valve is normally controlled with the following circuit: Locomotive battery, positive pole, resistance, wire *23*, contact *26*, wire *31*, magnet, wires *33* and *13* to locomotive battery, negative pole. This retains the magnet of the reservoir and brake valve energized, providing the contact *29* in the speed controller is closed. As the closing of contact *29* is dependent upon the adjustment to a predetermined speed, it will be closed when the train speed is under the predetermined speed. The result would be in a case where the ramp is not energized that all contacts of the three-position relay (except special) would be open. Hence, the circuit for the magnet of the valve must be open, de-energizing the magnet, in which case the electro-pneumatic valve will cause an exhaust of brake pipe pressure, thus applying the brakes automatically.

When the three-position relay is de-energized it may be energized to assume the negative or reverse position by pushing the release switch *C*. When this switch is operated the following circuit is established: Locomotive battery, negative pole, wire *13* and *38*, contacts *37*, wire *41*, resistance, wire *4*, coils of the three-position relay and neutral lock, resistance, wire *40*, contacts *36*, wire *39*, special contact closed *A* to *B* on three-position relay, resistance to battery, positive pole. With the three-position relay in the negative or reverse position as heretofore explained, the magnet of the electro-pneumatic reservoir and brake valve can only be energized through the speed controller contact *29*.

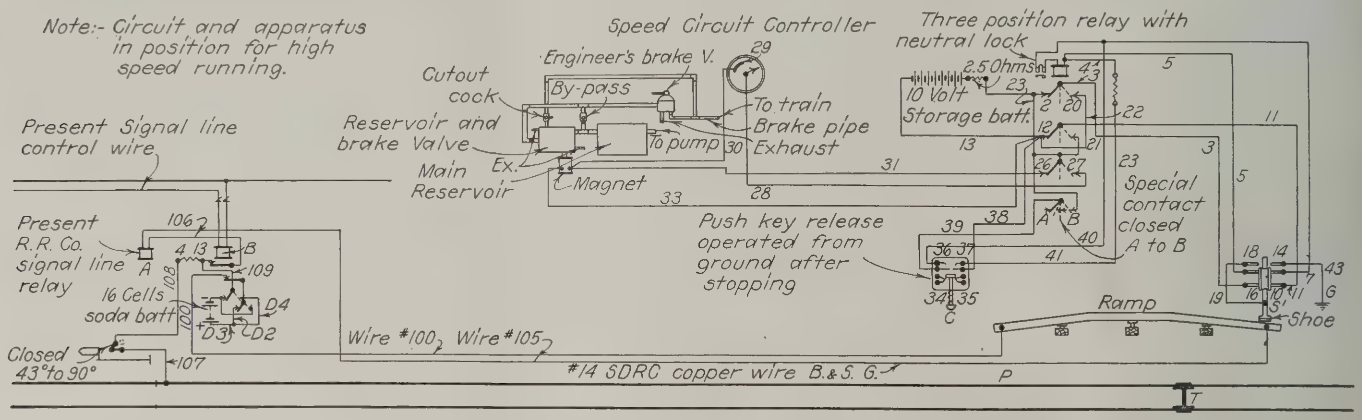


Fig. 6—Diagram of Circuits on the Locomotive and Way Side Signal Connections

Fig. 8—Induction Type Track Elements

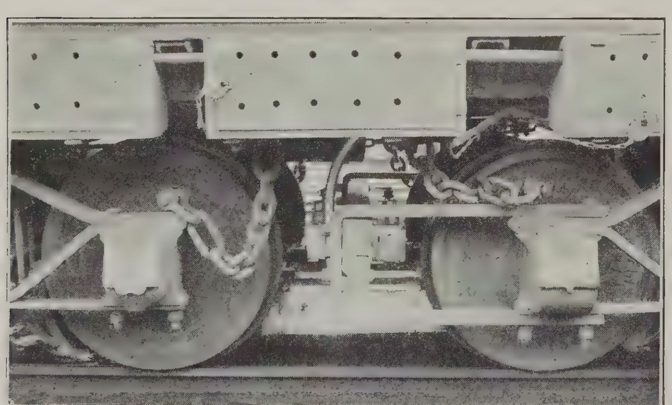


Fig. 7—Induction Receiving Apparatus on the Locomotive

The Regan Intermittent Induction Type

In this system of train control the speed controller and electro-pneumatic valve are the same as used in the intermittent electrical contact ramp type, while the inductor elements shown in Fig. 7 take the place of and perform the same function as the shoe mechanism of the ramp system. In addition to the speed controller and electro-pneumatic valve on the locomotive, there are three inductors, a tripping element and two reset elements, two holding relays, a release key, an alternating current generator of the headlight type and appropriate circuits. On the roadside are three inductors and one inert element, as shown in Fig. 8.

When the locomotive is operated over the inert road-

side elements, they influence the inductors on the locomotive to create a stop condition, but at the same time the inductors of the locomotive come within the influence of the inductors on the track such that a cycle of influence is established from the locomotive through the inductors on the track to the locomotive again.

The induction system, the same as the ramp system, is susceptible to a variety of combinations for automatic stop and speed control. No roadside energy is necessary in the operation of the train control. The clearance of the locomotive element above the track element is four inches. Nothing in the track is above the top of the track rails.

The Simmen System of Train Speed Control

Locomotive Equipment Includes Visible Cab Signals in Conjunction with the Automatic Mechanism for Applying the Brakes

THE Simmen Automatic Railway Signal Company has had one or more installations of its equipment in operation since 1907. The device is of the ramp rail and contact shoe type, the ramp rail being energized either through a remote control circuit from the dispatcher, or in connection with the signal system.

Cab Circuits

In addition to the automatic mechanism used in applying the brakes, the locomotive cab is equipped with signals which indicate at all times the condition of the track ahead. Two-position, three-position and six-position cab circuits have been developed. All of these are of the intermittent ramp rail and contact shoe type, and any impulse obtained from a ramp rail is continued by means of a holding or "stick" circuit until the next ramp rail is reached.

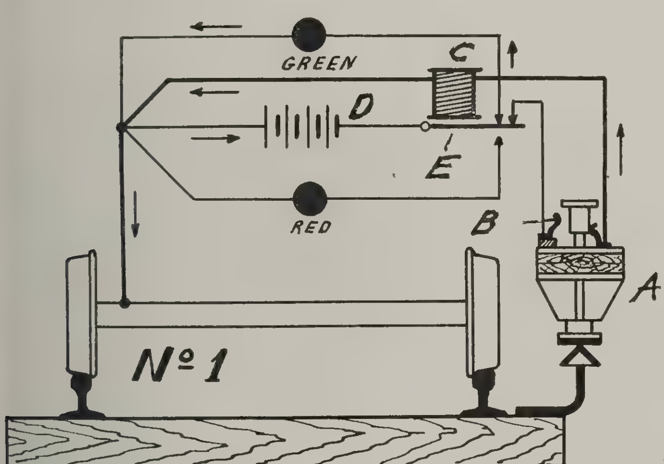


Fig. 1—Circuit Diagram With Red and Green Lights

In the two-position circuits, when the ramp rail is energized, a clear signal is displayed; when the rail is de-energized, a danger signal is given. Fig. 1 shows the two-position circuit. *A* is a contact shoe, *B* a switch which is opened when the shoe slides upon a ramp rail, *C* a relay, *D* a 10-volt storage battery and *E* the armature of the relay.

The operation is as follows: When the shoe slides up on the ramp rail, switch *B* is opened. If the rail is energized, current from a battery along the track will flow from the shoe through the relay to the axle to ground; when the shoe leaves the rail, switch *B* is closed, and a closed circuit known as a "stick" circuit is established as follows: From shoe *A*, through relay *C*, through battery *D*, through an upper or front contact of armature *E* to switch *B* and contact shoe, thus continuing the clear signal. Assuming that the next ramp rail is de-energized, the operation will be as follows: When the shoe slides upon the de-energized ramp rail, switch *B* is opened, and there now being no energy from the wayside battery, relay *C* becomes de-energized on account of the cab "stick" circuit now being open at switch *B*. The armature *E* drops to close a back contact for a danger signal circuit. As the shoe leaves the ramp rail, switch *B* is again closed, but the danger signal is continued, since the cab relay *C* is now open at the front contact of the armature *E*. This circuit not only displays the danger signal indication, but is also used to control the speed of the train.

Fig. 2 shows the three-position circuit. When the ramp rail is positively energized, a clear signal is given; when the rail is negatively energized, a caution signal is given and when the rail is de-energized, a danger signal. The operation is practically the same as for the two-position circuit, but there is a notable difference in the type of relay used. The relay shown in Fig. 2 is known as a polarized relay and requires some explanation to make its operation clear. The horizontal armature of this relay is exactly similar to the one shown in Fig. 1 and will be picked up and its contact closed regardless of the direction of current through the coils. The four

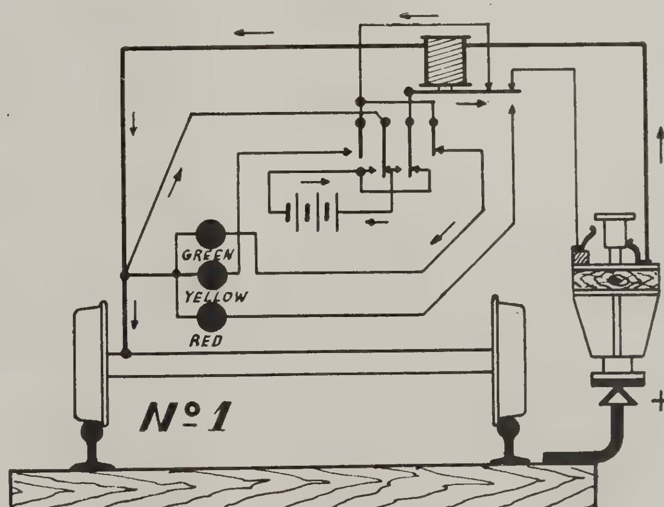


Fig. 2—Circuit Diagram With Red, Green and Yellow Lights

vertical armature contacts shown below and a little to the left of the relay coil, depend entirely for their position upon the direction of current through the relay windings. As shown in Fig. 2, the direction of current through the relay is such that these four polarized contacts, as they are called, are held against the right hand contact points. Should the current in the coil winding be reversed, as would be the case when contact shoe is upon the negatively energized ramp rail, these polarized armature contacts would swing over to the left.

With the foregoing explanation it is not a difficult matter to trace out the various circuits for the three conditions of the ramp rail.

Speed Control

Fig. 3 is a sketch showing the simpler form of the Simmen speed control apparatus. The cab circuits shown are the same as the two-position circuit shown in Fig. 1. Shaft *1* is directly driven from the axle of the locomotive. This shaft operates an ordinary speed governor *2*. Flange *3* of the speed governor rises and falls with the speed of the train. Number *4* is a motion transmitting mechanism driven by shaft *1*, which provides that shaft *5* is always driven in the same direction, whether the locomotive is going forward or backward. Gear train *6* constantly drives the gear wheel *7* in the same direction as long as the locomotive is in motion. Under clear signal conditions this gear is held electrically out of mesh with gear *8* by an electro-magnet *9*, which is controlled by the cab circuit. Gear *8* is fixed to shaft *10* and is a mutilated gear, having some of the gear teeth removed for a portion of its periphery. On shaft *10* a cam *11* is fixed. This cam is so shaped that it

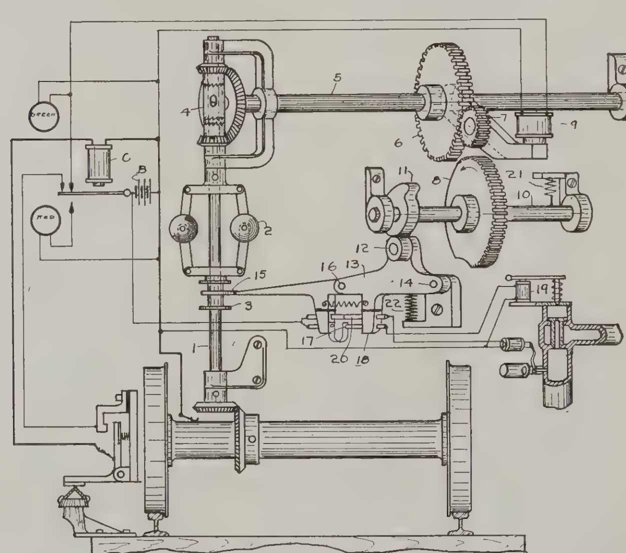


Fig. 3—Diagram of Simple Speed Control

embodies the speed reduction control feature. Cam *11* rides on a roller *12* and when the cam is in motion it gives movement to an arm *13*, which is hinged at *14*. A movable fork *15* hinged to main arm *13* at the point *16* is so placed that flange *3* of the governor can raise the fork. This movable fork *15* carries a contact *17*, which makes connection with another contact supported by frame *18*. Support *18* is fixed to the main arm *13*, but is insulated therefrom. As long as the electrical contacts are closed, a circuit is established through battery *B* and magnet *19*. Magnet *19*, when energized, holds closed an automatic valve in the train line pipe. Arm *13* also controls an additional contact *20*. This contact when open will actuate an air whistle in the cab. Contact *20* will open when the actual speed of the train is within a mile or two of the permissive speed; in other words, contact *20* will open slightly ahead of contact *17*, which controls the automatic application of the brakes. An engineman will therefore always get a warning before the air brakes are applied automatically.

The operation of the apparatus is as follows: When

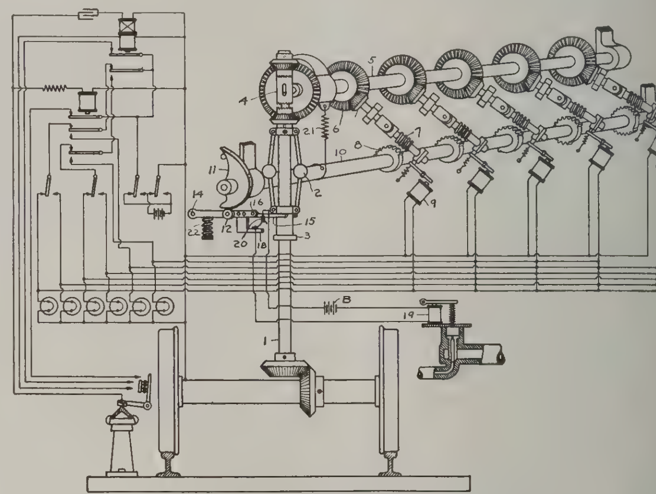


Fig. 4—Speed Control Apparatus for Six-Position Cab Circuit

the train is proceeding under a clear signal indication, gear *7* is out of mesh with gear *8* and cam *11* assumes its maximum speed position by the tension of the spring *21*. Arm *13* also assumes its maximum speed position by the upward pressure of spring *22*. Therefore flange *3* can be raised by the speed of the train until it touches the forked arm *15*. If the speed of the train is further increased, contact *20* will be opened, giving the warning signal; and if the speed is still further increased contact *17* will be open, thereby applying the air brakes automatically. As soon as the speed is thus automatically reduced, contacts *17* and *20* will close again.

When a train passes a de-energized ramp rail indicating that the next signal ahead is in the stop position, electro magnet *9* is de-energized and gear *7* will drop into mesh with gear *8*, thus giving movement to shaft *10* and cam *11*. The movement of cam *11* forces down on *13* and *15*, thus gradually reducing the speed; and if the engineman does not heed the warning signal, that is, not keep flange *3* of the governor below the forked arm *15*, an automatic application of the brakes may occur anywhere between the de-energized ramp rail and the stop signal which the train is approaching. By the time the train arrives at the stop signal, cam *11* will have been turned to its minimum speed position, of say 10 miles an hour, at which point gear *7* has entered the mutilated portion of gear *8*, and therefore no further movement is given to shaft *10* and cam *11*. If the conditions on the track ahead have changed so that the stop signal has been replaced by a proceed indication, the cab relay *C* will have been energized through the contact shoe from the ramp rail which the locomotive passed just prior to reaching the signal mentioned. Gear *7* would be lifted out of mesh with gear *8* by magnet *9*, cam *11* would

assume its maximum speed position and the train would proceed again at maximum speed. If the engineman passes the stop signal, it is possible for the train to proceed at 10 miles an hour throughout the danger block, but if the engineman attempts to exceed this minimum speed, he will receive first a warning signal and then an automatic application of the brakes.

Speed reductions at curves, grade crossings, etc., are accomplished by erecting a permanently de-energized ramp rail some definite distance ahead of the point where the speed is to be reduced, this distance depending upon the amount of reduction desired at the point. After the train has arrived at a point where reduced speed is required, the contact shoe on the locomotive passes over a normally energized rail, thus restoring cam *11* again including the minimum.

Where traffic conditions are so dense as to require more than one intermediate speed, the six-position cab circuit has been provided as shown in Fig. 4. The speed control apparatus is identically the same in operation, but five-gear trains and five mutilated gears are provided instead of one. The periphery of each of the five mutilated gears is mutilated to a greater degree, thus bringing cam *11* to rest at five different speed positions.

The Wooding Automatic Train Control

Angle and Velocity at Which the Shoe Engages the Ramp Regulates Train Speed When Approaching Too Near Unrealized Danger

THE Wooding Automatic Train Control device is of the intermittent electrical contact type, the most prominent feature of which is the ramp and train contact.

The type of ramp used in connection with the Wooding device consists essentially of two angle bars approximately 18 ft. long, held together with U-shaped springs and supported at the ends and in the middle by insulated and flexibly mounted iron brackets extending outward from the running rail. As the contact shoe, mounted on the locomotive, enters the ramp, the two overlapping angle irons, which are normally held together by the springs, spread apart so that contact is made on both sides of the shoe, or blade, with the edges of the angle irons. Fig. 1 gives a conception of the general appearance of the ramp in its unfinished state, although the more recent designs are refined from the one shown in the photograph.

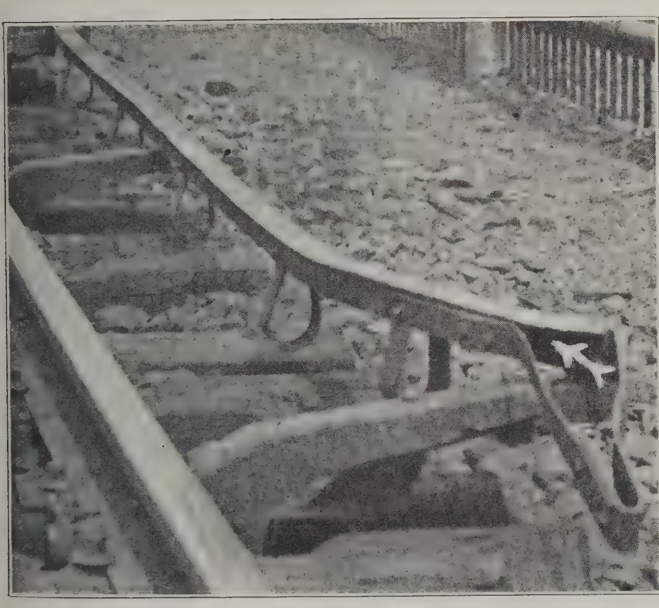


Fig. 1—Ramp Location With Arrow Indicating Point Where the Blade Enters

The locomotive equipment consists of a normally closed electric circuit, including a storage battery, the contact shoe and circuit breaker mounted on the forward tender truck, an electro-pneumatic valve installed in a branch of the brake pipe, optionally provided with a cutout cock and a knife switch. The speed control feature of the system includes a branch circuit normally opened at a push button installed in the cab, as well as speed control contact actuated by the contact blade and located in the circuit breaker housing on the forward tender truck.

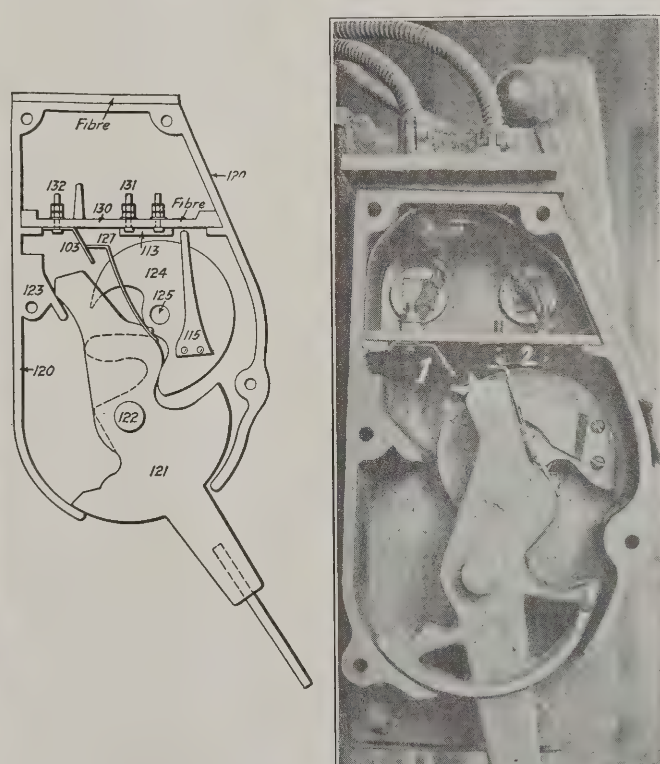


Fig. 2—Diagram and Photograph of the Unit on the Locomotive With the Cover Removed

The contact shoe or blade, as it may be more properly termed, differs from other train control devices in that the movement imparted to it by the ramp rail is lateral rather than vertical, and permits of higher carrying.

Operating Features

In normal operation the circuit on the locomotive is intended to be broken by lateral deflection of the contact shoe when engaging a ramp. If the track ahead is clear, an electric impulse will be imparted to the contact shoe from the local battery through the ramp and the valve magnet on the locomotive will be maintained in the closed position. Should the track ahead be occupied by another train, the ramp will be de-energized and the circuit through the valve magnet will be opened, causing an application of the brakes. The reduction of speed on dangerous curves is provided for by reversing the connection of the local battery to the ramp and absence of return connection, in effect causing the ramp to be dead, necessitating the engineer's attention to close the branch circuit, which he can only do providing he is running his train under the speed limit.

The Speed Control Feature

The operation of the speed control feature of the system is dependent upon the action of an unbalanced gravity wheel or cam operating to form part of the branch circuit at the contact blade circuit breaker. The arrangement of these parts may be understood from an inspection of Fig. 2. In the diagram at the left, the cam carries a contact spring *115*, which, upon deflection of the contact shoe while passing through a ramp, engages another contact segment *113* mounted on an insulated block in the upper part of the housing, closing one of the two open points in the speed control branch of the locomotive circuits. If the rate of speed is below certain predetermined points, cam *124* is not intended to complete its entire stroke, but to be moved only into position to close the contacts *113-115*, and to maintain these contacts closed as long as the shoe is engaged with the ramp. Angular differences in the design of the ramp controls the speeds only in case of danger. In case the speed is above the predetermined rate, the quicker and more abrupt becomes the deflection of the contact blade, which imparts sufficient momentum to the cam to throw it over its center. Under these circumstances the speed control contact *113-115* is closed but momentarily and is broken again as the cam passes over its center and completes its stroke, the contact point being held open during practically the entire time the blade is in engagement with the ramp and being restored to normal position again by the action of the shoe returning to normal position in passing out of the ramp. Under these conditions the branch circuit being open at the speed control contacts in the shoe circuit breaker, the engineman is unable to maintain the valve magnet energized by closing the push button, and he is, therefore, not able to pass a de-energized ramp above the predetermined rate of speed without receiving an automatic application of the brakes.

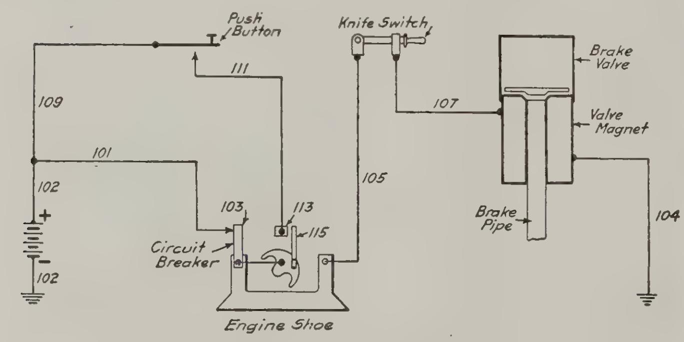


Fig. 3—Diagram of Circuits on the Locomotive

Fig. 3 shows a diagram of the circuit on the locomotive. The speed control branch consists of wire *109*, leading from the positive side of the battery to the engineer's push button and is normally open; wire *111*, contact *113*, normally open, contact spring *115*, which is permanently connected to the speed control cam, and thence through the shoe, wire *105*, knife switch, wire *107*, valve magnet, to ground. When the contact shoe is deflected upon engagement with a ramp, the cam carrying contact spring *115* is rotated about the stud upon which it is mounted, closing contact *113-115;* if the rate of speed is below the speed control limit this contact is maintained closed as long as the engine shoe is in engagement with the ramp, and if the engineman's push button is held closed the valve magnet is maintained energized, even though the ramp is de-energized. If, however, the rate of speed is above the speed control limit, on account of the inertia of the cam and the quicker movement imparted by the engagement between the contact blade and the ramp, the cam is carried over its center by momentum and the contact spring *115* is carried past the segment *113;* the contact is therefore closed only for an instant and is immediately broken and held open as long as the contact shoe is in engagement with the ramp. The speed control branch of the engine circuit is therefore open at

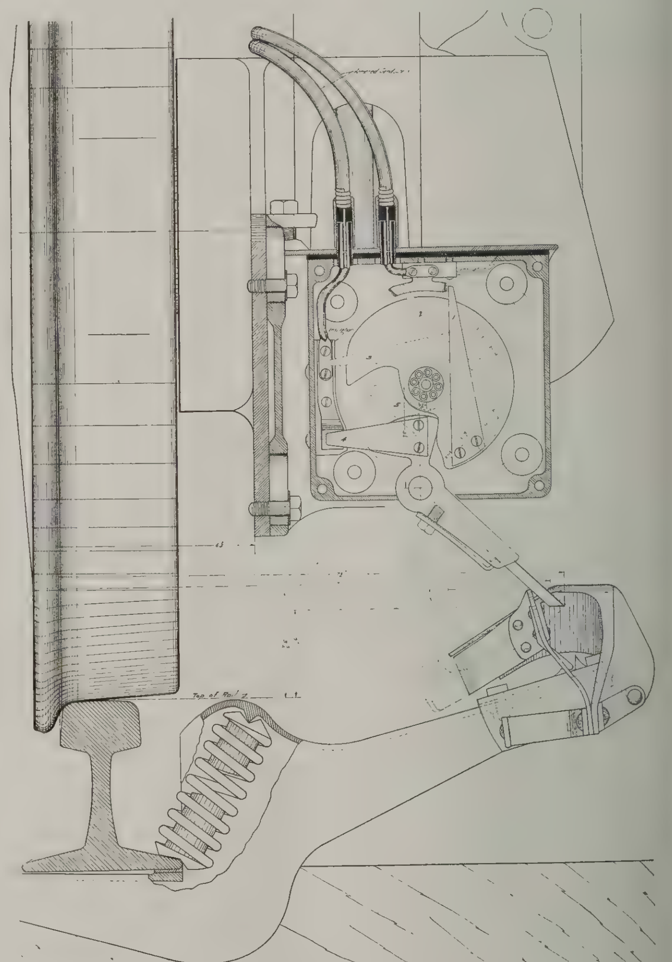


Fig. 4—Line Drawing of Latest Type Circuit Breaker and Shoe

the blade circuit breaker whenever the rate of speed of a train while passing a ramp is above the predetermined speed control limit. The contact segment *113* is curved and so arranged that on the return movement of the cam the contact spring does not engage the face of the segment *113*, but passes on the opposite side and does not make electrical contact except for a very brief instant on returning to normal.

The magnet valve is an electro-pneumatic valve having a resistance of approximately 16 ohms. The connection with the brake pipe is made between the engineman's brake valve and the double-heading cock and consists of a ¾-in. pipe which extends directly through the magnet valve. In service an angle cock in this pipe connection is intended to be sealed in open position.

The magnet armature consists of a circular metal disk, carrying a ball which fits into a valve seat in the end of the brake pipe connection which leads through the magnet core; the ball also serves to hold the armature away from the coil, and its position is adjustable.

While the diagram and photograph shown in Fig. 2 illustrate the principles upon which the device is based, a more recent design is shown in Fig. 4, where it will be seen that the shape of the circuit breaker box has been somewhat modified and made more easily adjustable. In this sketch various positions of the rotating cam are shown and the succession of numbers *1*, *2* and *3* show the corresponding position of the contact spring *115*. Contact spring *4* is attached to the opposite end of the arm carrying the contact shoe. This corresponds to contact *103* in Fig. 3, and is shown in its normal position. When the contact shoe enters the ramp, the blade is deflected downward and contact spring *4* will occupy the position shown by *5* while the shoe is in the ramp.

The Miller Automatic Train Control

Audible Signal Is Given to Engineman by Pneumatic Whistle as Each Ramp Is Passed

THE Miller train control is of the intermittent electrical contact type, using the roadside ramp. The electrical equipment on the locomotive consists of a normally de-energized electro-magnet that receives energy from the ramp.

Wayside Apparatus

The wayside ramp is made of 4 in. by 5 in. T iron inverted, supported on malleable iron stands, which are

Ramp Location With Relay Box

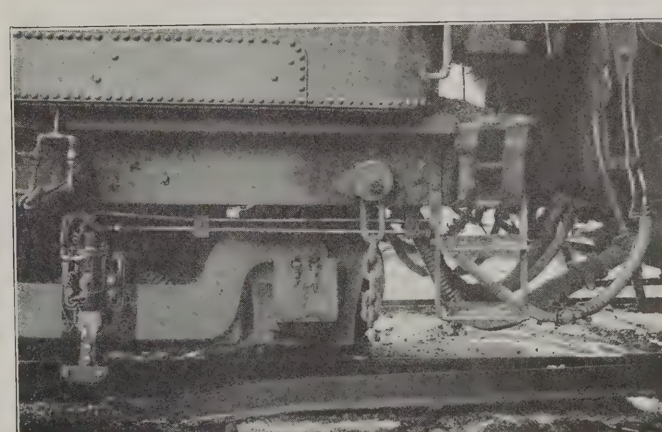
fastened by lag-screws to every sixth tie. The ramp is set to a clearance of 22 in. from the gage side of the running rail, with a maximum height of 6 in. above the rail at the center and a gradual decline toward the ends. The main part of the ramp is insulated from the end sections, which are bent down and buried in the ballast. Ramps are located at braking distances from the automatic signals. This distance varies according to grade, curves, etc.

The ramp is energized by 16 cells of 500 a. h. primary battery, which is placed in a battery box near the ramp. The negative of this local battery is connected to the running rail and the positive is fed through a contact of a relay to the ramp. This relay, housed in a cast-iron box at the ramp location, is controlled by a circuit that is dependent upon the conditions on the track ahead.

Equipment on the Locomotive

The automatic stop equipment on the locomotive consists of the shoe, an electro-pneumatic valve and a pneumatic mechanism for operating the engineman's brake valve handle.

The shoe housing which carries the contact shoe is attached to a cast steel bracket securely fastened to, and insulated from, the arch bar of the forward truck of the tender. Hard iron insert blocks, that are renewable, fit in the bottom of the shoe where it rubs on the ramp. There



Contact Shoe, Showing Air Pipe and the Wire to the Cab

is a ½-in. air pipe leading from the control mechanism in the cab to the shoe and a conduit that carries the one electrical wire. Connection between the engine and tender is made with a standard air hose coupler. The air pressure tends to force the shoe down, and as the air

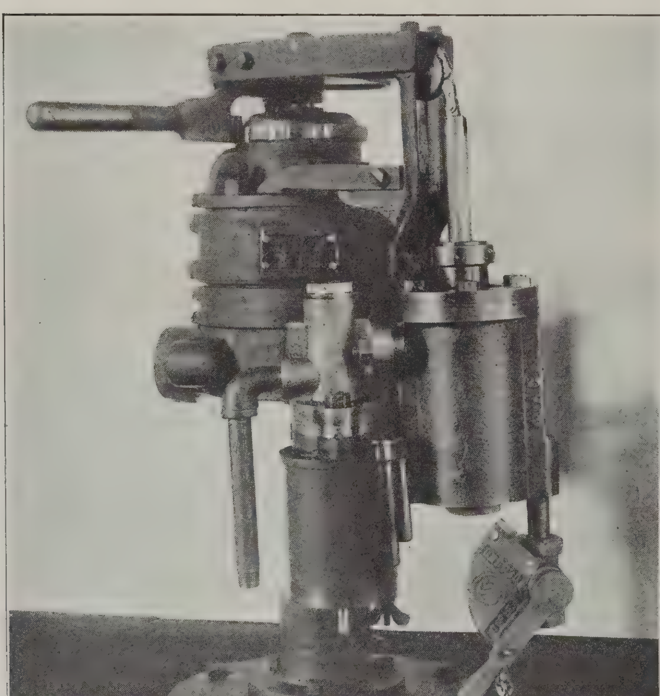
connection is extended into the hollow part of the shoe, in case the shoe is broken off the air is exhausted, causing an application of the brakes.

Attached to the side of the engineman's brake valve is the automatic stop instrument, consisting of an electro-pneumatic valve and the pneumatic mechanism to operate the engineman's brake valve handle. The magnet coil has a resistance of approximately 4 ohms and draws about 2 amperes when passing over a clear ramp.

Description of the Operation

As the shoe engages a ramp the plunger is raised and the air line *L* to the shoe is opened to atmosphere. Providing the signal is clear and the ramp is energized the current from the ramp follows wire *N* to the magnet coil, which is at once energized, lifting the plunger and closing the valve *V*, which prevents further exhausting of aii pressure through the pipe *K* to the shoe. This operation, of course, leaves the remaining apparatus in a *status quo* condition. When the shoe passes off the ramp the sòlenoid magnet is released and valve is opened; however, at the same time the shoe closes the port in the shoe housing and air is not allowed to exhaust through *K*. As an indication to the engineman, the small whistle to the left of the magnet is blown continuously while passing a clear ramp.

When the signal is at danger the ramp is not energized, therefore, when the shoe is raised the port in the shoe housing is opened and air is free to exhaust through the



Magnetic Air Valve and Air Mechanism for Operating Engineman's Brake Valve

pipe-line *L* and *K*, and as there is no energy to pick up the solenoid magnet the valve *V* remains open. Air is thus free to exhaust out of the chamber below the piston *P*, which is forced down by air pressure from the reservoir. As piston *P* goes down the chain *W* (which is tested for 1,000 lb. breaking strain) pulls the wheel *O* around, bringing the brake handle to the service application position.

The engineman if alert may forestall the automatic application of the brakes by lifting the stem of the magnet armature, which extends below the magnet for this purpose. However, such action on the part of the enginemen can be prevented and the train automatically brought to a stop for each stop application by eliminating the extension

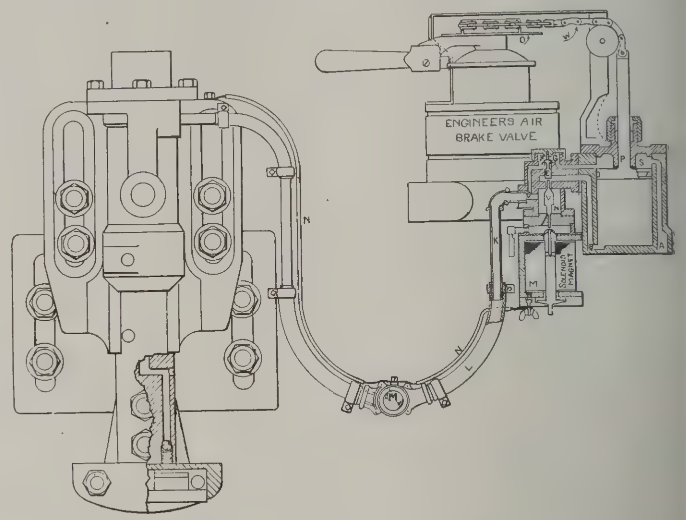


Diagram of the Shoe, the Air Valve and Operating Mechanism

of the stem below the magnet armature housing and having it self-contained therein. Speed control and other adjuncts to the stop system may be incorporated as a part of this device.

A Record Earth Dam.—An earth dam which, it is said, will be the highest ever made, is being constructed by the United States Reclamation Service on the Tieton River in Washington. It will be 232 feet high by 900 feet long at the top, with a reinforced concrete core wall. The core is being sunk 100 feet below the river bed by sinking shafts to the full depth, and tunnelling along the dam. The tunnel is extended upwards by a stoping process and filled with concrete as the work progresses. In this way the expense of timbering an open trench is avoided.

Photo by Underwood & Underwood

A Radio Telephone on the Rocky Mountain Limited, C. R. I. & P.

Battery Maintenance on the Northern Pacific

Simple Apparatus Reduces Labor Required for Cleaning and Repairing Car Lighting Batteries

An unusually well developed method of maintaining car lighting batteries is in use at the Como shops of the Northern Pacific. The method is particularly worthy of note as very little special apparatus is used, and that which is used can be obtained or made in practically any railroad shop.

One end of the car repair shop is devoted to the maintenance of all the electrical apparatus used on the cars. When a car is shopped for general repairs, the battery is pulled out of the battery box on to a truck which is the same height as the bottom of the battery

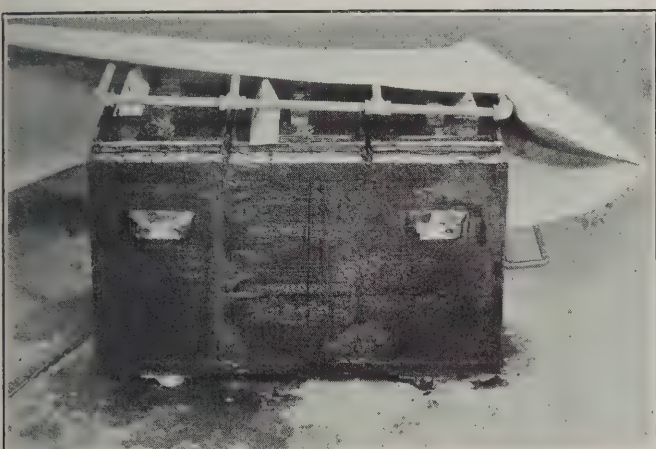


Fig. 1—A Few Pieces of 1/8-In. Pipe and a Piece of Rubber Matting Provide Means for Softening the Sealing Compound

box and taken to the end of the shop. The towing of these trucks is generally done by an electric tractor. The tables or benches on which the batteries are placed while being charged and tested are also the same height as the truck so that the lifting of batteries is reduced to a minimum.

The first operation, after the battery is removed from the car, consists of cleaning off the dirt. This is done with a hose and hot water. The cover sealing compound is softened with steam. Several pieces of 1/8 in. pipe fitted together facilitate this operation. These pieces of pipe are so fitted together as to form a sort of grid which just matches the lines of sealing compound used to hold the covers in place. There is a large number of small holes drilled in the lower sides of the pipes which form the grid. The grid is connected to the steam line with a hose and is placed on top of the battery on plate rests as shown in Fig. 1. A piece of rubber matting such as is used on car platforms is then thrown over the battery and pipe grid and the steam turned on for a few moments. The cover sealing compound is then peeled out of its groove with one of the tools shown in Fig. 2. This tool has the appearance of a heavy screwdriver with an offset shank.

After the cover is removed the elements are lifted out with the two hooks, also shown in Fig. 2, made of bent spikes and sections of broom handle. In case the plates are warped so that they cannot be lifted from the tank easily, the two heavier hooks and the piece of 2 x 4 shown in Fig. 2 are used. The two ends of these hooks which are turned out are placed under the connecting strap on each set of plates. The 2 x 4 is then placed under the upper ends of the hooks which are turned in, and is used as a lever to loosen the elements in the tank. The manner in which some of these tools are used is shown in Fig. 3.

The electrolyte is then dumped into one end of the large wood tank shown in Fig. 4. This tank has two compartments for electrolyte and for washing, respectively. This electrolyte is tested in the railroad laboratory, which is a part of the same car shop, and if it does not contain iron or other foreign substances that are injurious, the specific gravity is brought up to normal and the electrolyte is used again.

After the electrolyte is dumped out of the battery tanks, the crate and tanks are slid along the sloping planks over the washing tank and the sediment is washed out with a three-jet washing nozzle as shown in Fig. 4.

Fig. 2—The Special Tools Used for Removing Covers and Elements Can Be Made Easily in Any Shop

The elements are placed on the grating taken from a dining car ice box shown in the foreground in Fig. 4. Under this grating there is a box arranged with a series of baffle plates to catch the sediment, part of which is washed off the plates and part of which comes from the overflow of the washing tank. The box under the grating is drained in turn through a long trough, a section of which is shown in Fig. 5. This trough is also fitted with baffles. The baffles fit into grooves in the side boards of the trough and when it becomes necessary to

clean out the accumulated sediment, the baffles are pulled out and sediment is scooped out with a shovel which just fits the trough.

Warped plates are straightened with the aid of a press made from a 10-inch air cylinder which is mounted on a bench covered with galvanized iron. Plates which have grown and are too long, are cut off with a hand saw while they are in the press. The bench on which this work is done is kept clean with an air hose. Separators are washed in a tub made of a half barrel filled with water.

The batteries which are handled vary in size from 300 ampere hour cells in lead tanks to 60 ampere hour cells in rubber jars. The smaller cells are washed over the washing tank without removing the elements. The solid type battery boxes are used for all batteries.

Steam is also used for removing the tanks from the battery boxes. The end of a steam hose is pushed into a tank and a piece of rubber matting is laid over the top. When the compound is soft enough the tank is lifted out with the aid of two pairs of pliers.

When the tank is removed it is straightened with the

Fig. 3—The Tools are Used in This Manner

blocks and wedge shown at the left in Fig. 6. The blocks are placed inside the tank and the wedge is pushed down between them, thus straightening the tank.

The first part of a tank to become pitted is usually the bottom and the sides near the bottom and many old tanks can be made practically as good as new by replacing the bottom. New bottoms are cut out with the aid of the templet shown leaning against the post in Fig. 6. In some cases new sheet lead is used for this purpose and in others the sides of old tanks are used for making the bottoms. After the lead is cut out the same shape as the templet, it is placed over a block which has the same dimensions as the inside of the tank and the edges of the sheet are bent over the block so as to form a bottom, together with sides about two inches high. The old tank from which the bottom and two inches of the sides have been removed is then placed over the form shown at the right in Fig. 6, and the new bottom is burned to the old sides and the seams in the new bottom closed. Plate rest retainers are placed in the recesses in the bottom of the form before the new bottom is applied and these are secured to the bottom by burning through the bottom. The form is made of wood covered with galvanized iron. All lead burning is done by the oxy-acetylene process.

The repaired tank, or lead lining as it is often called,

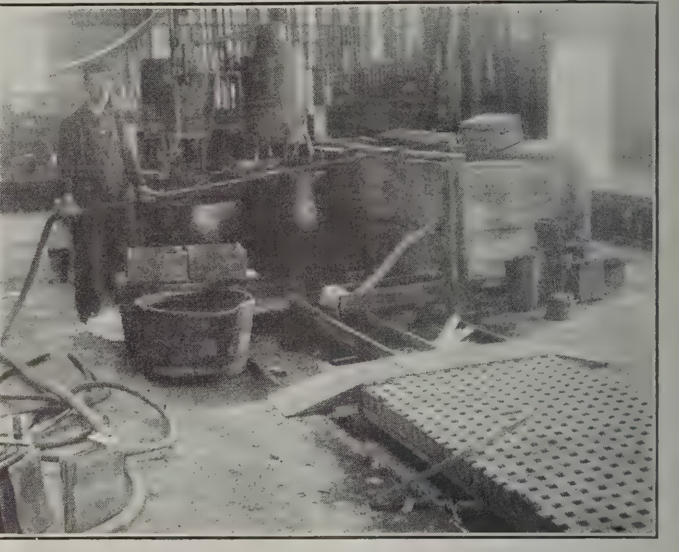


Fig. 4—Facilities for Washing Tanks and Plate Groups

is then painted with an acid proof paint. When it is to be replaced in the battery box it is again put on the form and pushed into the box which has previously been partly filled with hot compound. The elements are then replaced, the cell filled with electrolyte and the cover applied and sealed. Sealing compound is heated in a kettle over a plumber's torch as shown in Fig. 4. Before being replaced in the cars, the batteries are charged and after being charged the specific gravity in each cell is

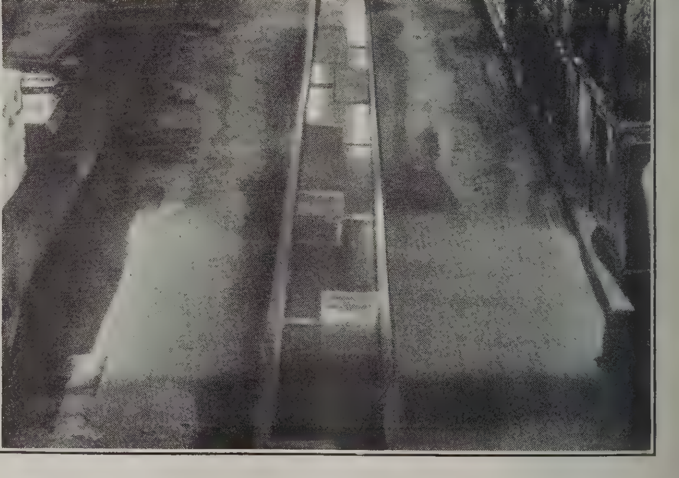


Fig. 5—Baffles in the Overflow Trough Catch the Sediment

raised or lowered slightly, if necessary, by adding water or electrolyte, so that it is equal in each cell.

The benches on which the batteries are placed for charging, etc., are wired in conduit with "Ralco" receptacles, properly located, to facilitate easy connection and disconnection of the batteries without the use of temporary wiring.

A slate switch board controls the charging of the bat-

teries and also the discharging of same when ampere hour tests are run. Besides the ammeter and voltmeter with plugs and receptacles for switching same, each circuit is equipped with a rheostat, an ampere hour meter, a combination overload and under load circuit breaker and a double pole, double throw switch by which proper

Fig. 6—Wedges for Straightening Lead Tanks and Templet and Form for Repairing Them

connections are made for either charging or discharging a battery.

The water still and mixing tank are shown in Fig. 7. The tank at the left, which is made of copper, is the still. This tank is kept nearly full of water and the water is boiled by a steam coil inside the tank. The barrel at the right is kept full of cold water by keeping a small

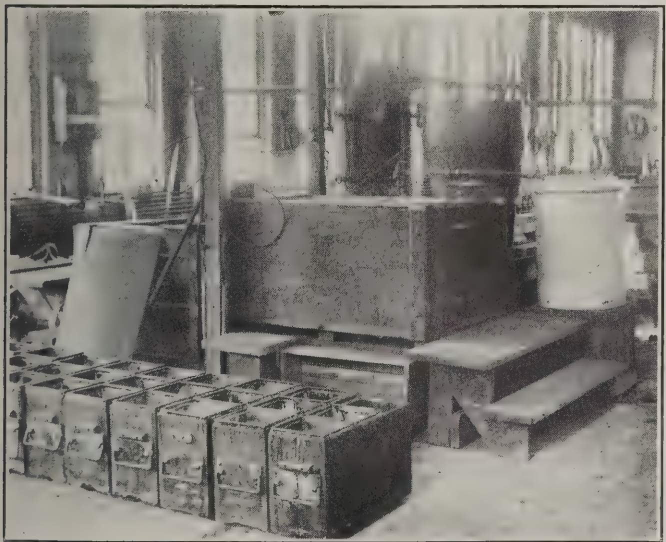


Fig. 7—Water Still and Acid Mixing Tank

amount of water flowing through it from the shop water supply mains. The steam from the still is carried down through the cold water in a coil of copper pipe and the distilled water from the pipe is drained either into the mixing tank in front of the still or into the large crock at the right. After the acid has been added to the water in the mixing tank, the electrolyte will be siphoned into the battery tanks shown in the foreground through a rubber hose. The water in the large crock will either be kept for future use or will be drawn off into carboys and shipped to outlying points where it is necessary to flush or clean batteries.

American Engineering Standards

INSULATED wires and cables constitute the biggest single item of manufactured electrical devices and machinery, their value being about 17 per cent of the total value of all such equipment.

Many engineering societies and commercial organizations have issued standard specifications for them which have come into very general use. Indeed, at the present time there are something like fifteen such specifications in wide use in the United States.

All of these specifications, however, are made to apply to specific industrial uses and little has been done to co-ordinate them. It has, therefore, become a matter of concern to both manufacturers and users of wire to bring about some co-ordination, with the idea of establishing a definite set of American standards.

The first step toward this was taken last winter when the following ten engineering societies and other public organizations agreed to act as sponsors, under the auspices of the American Engineering Standards Committee, for a comprehensive standardization of electric wires and cables for other than telephone and telegraph use:

American Electric Railway Association
American Institute of Electrical Engineers
American Railway Engineering Association
American Society for Testing Materials
Associated Manufacturers of Electrical Supplies
Association of Edison Illuminating Companies
Association of Railway Electrical Engineers
National Board of Fire Underwriters
National Electric Light Association
National Fire Protection Association

These organizations enlisted the co-operation of several others, and created a comprehensive group of committees to handle the work. The other co-operating organizations are:

Associated Bell Telephone Companies
Electric Power Club
Society of Automotive Engineers
U. S. Dept. of Commerce
U. S. Dept. of Navy
U. S. Dept. of War

The first meeting of the sectional committee was held at the headquarters of the American Society of Mechanical Engineers on Friday, December 6, 1921. At this meeting, a formal plan of organization and procedure was adopted, officers elected, and the work definitely launched.

There are twelve technical committees to which specific phases of the work have been assigned. Like the sectional committee itself they are organized under the representational plan; that is, they are made up of representatives designated by the various organizations concerned in the particular subject with which each committee deals. These committees with their chairmen are as follows:

Definitions	W. A. Del Mar
Copper Conductors	J. A. Capp
Stranding	H. A. Morss
Rubber Insulation	F. M. Farmer
Impregnated Paper Insulation	D. W. Roper
Varnished Cloth Insulation	L. L. Elden
Magnet Wire	R. W. Longley
Fibrous Coverings	C. B. Martin
Metallic Coverings	W. I. Middleton
Standard Make Ups	C. A. Greenidge
Export	W. S. Clark
Weatherproof, Heat Resisting and Similar Materials	

The officers of the sectional committee and other members of the executive committee are:

Chairman, W. A. Del Mar, Chief Engineer, Habirshaw Electric Cable Co.; vice-chairman, E. B. Meyer, Asst. Chief Engineer, Public Service Electric Co. of New Jersey; secretary, F. J. White, Electrical Engineer, Okonite Company, 501 Fifth Avenue, New York; F. M. Farmer, Chief Engineer, Electrical Testing Laboratories; Dean Harvey, Engineer in Charge of Materials Section, Westinghouse Elec. & Mfg. Co.; E. B. Katte, Chief Engineer, Electric Traction, New York Central Railroad Co.; and Dana Pierce, National Board of Fire Underwriters.

The task before this sectional committee is one of the largest yet undertaken under the auspices of the American Engineering Standards Committee. The total number of engineers participating in the work is over one hundred and thirty, and the list includes most of the men who have achieved distinction in the field of wire and cable engineering.

Conference on Crossing Specifications

At the request of the American Electric Railway Association, a conference is being called by the American Engineering Standards Committee to decide whether there shall be uniform specifications for the crossing of overhead wires, and to dispose, if possible, of certain differences of opinion in regard to those parts of the National Electrical Safety Code which deal with overhead lines.

The following has been planned for the conference:

1. Shall there be a set of national specifications for crossings between overhead electric wire lines and railways, and between different wire lines?

2. If so, what should be its relation on Part 2 of the National Electrical Safety Code, "Rules for the installation and maintenance of overhead and underground electrical supply and signal lines."

3. Can disposition be made of the differences of opinion on Part 2 of the National Electrical Safety Code by
   (a) approving the present edition,
   (b) revising the present edition through a sectional committee of the American Engineering Standards Committee?

4. What procedure shall be recommended for carrying out the conclusions reached by the conference?

The American Electric Railway Association has summarized its reason for calling the conference as follows:

"For many years various associations and interests, either individually or jointly, have developed and in many instances adopted, specifications intended to govern the construction of electric light, power, trolley, signal and communication lines across steam and electric railways.

"Recently the National Bureau of Standards has promulgated the National Electrical Safety Code, Part 2 of which applies to the general construction of overhead lines, including requirements at railroad crossings. The differences between the several specifications and codes has led to confusion.

"Realizing the desirability of having a standard that would be generally acceptable, the American Electric Railway Association has requested the American Engineering Standards Committee, by conference of the bodies interested, to determine the desirability of developing an American Standard Specification which will include the requirements at railroad crossings."

International Co-operation in Standardization

The Standards Committee has just completed arrangements by which co-operation with the standardizing bodies in other countries will be made more effective. In doing this it has followed out the recommendations of the Unofficial Conference of the Secretaries of the National Standardizing Bodies held in London in April, 1921.

In order that all standards shall be available to the industries of the various countries, it is planned that each national body will sell the approved standards of the other bodies. The American Engineering Standards Committee (29 West 39th St., New York City) has available the publications of the standardizing bodies in Austria, Belgium, Canada, France, Germany, Great Britain, Holland, Sweden and Switzerland.

Induction Motor for U. S. Super-Dreadnaughts

The large motors being built to electrically propel the super-dreadnaughts included in the Naval program adopted by the Limitation of Armaments Conference are undergoing tests at the East Pittsburgh works of the Westinghouse Electric & Mfg. Co. Four motors are required to propel one battleship, one motor being directly coupled to each of the four shafts.

Each motor is rated at 16,500 horsepower with 227 revolutions per minute and they are almost identical in characteristics and appearance to the 22,500 horsepower motors which are the largest ever built.

The motors are designed for the most economical operation at two ship speeds, the battle speed of 23 knots and and the cruising speed of 15 knots. This result is obtained by the use of two entirely separate stator and rotor windings in the motor. At the battle speed, one set of windings is used and, at the cruising speed, the other set is operative.

Sixty thousand cubic feet of air per minute are required to conduct away the heat losses developed in operation. This amount of ventilation air for a period of 50 minutes is equal to the weight of the motor.

A general specification of alternating current motors for the main roll drive of a rolling mill has been compiled by and is available in pamphlet form from the Association of Iron and Steel Electrical Engineers, 1007 Empire Building, Pittsburgh.

Electrical Operation in Mountain Districts*

An Outline of What Is Being Done on the Chicago, Milwaukee & St. Paul

FOLLOWING is an abstract of a paper read by Frank Rusch, superintendent of motive power, C. M. & St. P., Tacoma, Wash., at a traveling engineers' staff meeting held at Milwaukee, Wis.:

We are operating electrically on the main line over five mountain ranges, formerly the most difficult parts of the system, the Cascade and Saddle mountains in Washington, and the Bitter Root, Rocky and Belt ranges in Montana. On a total of about 660 route miles we have two maximum gradients of 2 per cent to 2.2 per cent for about 20 miles; two grades of 1.6 per cent to 1.7 per cent, and several of 1 per cent.

In freight service on grades of less than one-half per cent we can handle as much tonnage as the operating conditions will permit with one electric locomotive at speeds which may vary up to 30 miles an hour. On 1 per cent grade ascending one electric locomotive will handle 3,500 tons; on 2 per cent grade, 1,250 tons; on 2.2 per cent grade, 1,100 tons; all at a speed of about 15 miles an hour. We ordinarily use a helper locomotive in freight service on mountain grades so that our average freight trains will run about as follows:

1 per cent grade	3,500 tons
1.6 per cent grade	3,200 tons
1.7 per cent grade	2,800 tons
2.0 per cent grade	2,500 tons
2.2 per cent grade	2,200 tons

These ratings are based on the continuous capacity of the locomotives which occurs at 15 miles an hour at full trolley pressure of 3,000 volts.

In making comparison with the steam locomotives that were used prior to the electrification the tonnage rating and what was actually hauled over the Rocky mountains is as follows and applies to freight trains only:

2 Mallets, Butte Yard to Donald	2,500 tons
2 L2 Engines, Butte Yard to Donald	1,600 tons
2 Electric, Butte Yard to Donald	3,200 tons
2 Mallets, Piedmont to Donald	1,800 tons
2 L2 Engines, Piedmont to Donald	1,400 tons
2 Electric, Piedmont to Donald	2,500 tons

The tonnage hauled over this mountain is greatly in favor of the electric motors. The mountain grade from Butte Yard to Donald is 1.6 per cent and from Piedmont to Donald on the east slope is 2 per cent.

On the 2 per cent grade over the Saddle mountains in Washington two electric motors haul 2,200 tons at a speed of 15 miles an hour, whereas two Mallet engines haul 1,600 tons at a speed of about eight or ten miles an hour.

In passenger service we are not using any helper power. These locomotives are built strong enough to handle 960 tons of passenger equipment over any portion of our track. They make good speed in ascending grades and their speed on level track is only limted by operating conditions.

In switching service we have electric locomotives at Butte, Deer Lodge and Othello. In special service we have used electric locomotives to push snow plows, on work trains and for wrecking outfits, and obtained efficient results.

*Milwaukee Employees' Magazine, March, 1922.

Fuel and Water Stations Eliminated

One thing which seems of considerable importance to the steam man in first operating an electric locomotive and which is soon likely to be forgotten with other commonplace things, is that no stops are necessary for fuel or water. When you consider the delays, train troubles and extra work of watering engines, encountered in mountain traffic, you can see that the complete elimination of such is no small item in bettering train operation. When you consider that a large part of our mountain district is through comparatively dry territory the elimination of pumping plants to supply this water represents economy.

Another feature which applies to all kinds of service and of which we have good report is that although the electric locomotives weigh more on drivers than any steam power, they are easier on curved track, at least, than the steam engines. On tangent track the difference is not so apparent, but it may be stated that there have been no radical changes made in track construction since we electrified, nor has there been any apparent reason for making changes. Considering that mountain trackage has a high percentage of curvature, this advantage of electrical operation is appreciable.

But in order to deal specifically in bringing out advantages of electric motive power in the mountains, it will be better to go more into detail. I can perhaps do this best by considering different kinds of service separately and by giving examples of actual operation.

First in importance is the freight service in which we have reduced the number of engines required and the work of keeping them in service. We have practically reduced our running time between points by 40 per cent and have increased our tonnage in the worst districts by about the same amount. In spite of increased tonnage the drawbar reports show a decreased number of accidents of this nature after the men have become accustomed to electric operation. The fuel consumption or kilowatt hours at the locomotive shows marked economy and there is no doubt but that with a sufficient number of trains operating, marked economy for the whole system is possible over steam operation.

Regenerative Braking Does More Than Return Power to Trolley

Freight trains can be handled over mountain grades without stopping and due to the regenerative feature may be handled without applying an air brake on the whole train, unless for some reason it is necessary to come to a dead stop. The regenerative braking not only saves the brake rigging but also returns energy to the trolley which may be utilized in helping move other trains. Whatever may be the return on this regenerated energy the saving made in ease of train handling with less number of break-in-twos with consequent damage and delays, is an important advantage.

The various tests on brake shoes in making a run from Avery to Harlowton show that about one-fourth of the

brake shoe was worn away in controlling the speed of the trains on mountain grade, while in the westward movement between these two points it showed approximately one-fifth of the brake shoe worn away. A conservative figure on the value of the metal dissipated through brake shoe wear during a thirty-day month period would be $6,000; this is not including the saving in the way of tracked wheels through overheating. Both of these items of expense have been practically eliminated through electric operation.

We expect at some future date to combine regenerative braking which sends the current back into the wire and which we have at present, with rheostatic braking which consumes the braking energy in the starting resistors, so that we can use electric braking at speeds down to practically a standstill. This will be a matter for experimentation.

Starting freight trains on ascending mountain grades is comparatively easy and not at all likely to result in drawbar damage. The helpers are placed in the middle of the train and the head locomotive can when starting let the slack back as far as the helper. The helper man then can advance his controller to give maximum tractive effort and is ready to follow with the slack when the head locomotive starts. With electric operation we have quit breaking drawbars almost entirely in the mountains.

We do not need engine watchmen with electric motive power and at any point where one of these machines is tied up it is only necessary for the enginemen to drop the pantographs and shut the doors and windows. This is particularly advantageous at helper tie-up points. At Butte and Piedmont when we first electrified we had as high as six to ten steam engines, mainly required for helper service. These were replaced with two electric locomotives, which have successfully done the freight helper work since. The passenger trains not requiring helpers have to some extent made this possible of course, but this itself is also another advantage of electrical operation.

Reg-nerative braking makes it a decided advantage to use a helper descending a grade as well as in going up on the other side. We have only one heavy grade on the Cascade mountains where this is not applicable. Otherwise our helpers ordinarily go clear over the summits. It is common for a helper to go in a train upgrade to Boylston and down to Beverly then back to Kittitas light with zero net consumption of kilowatt hours, or regeneration in this case, making it possible to operate helpers in eastward traffic from this point at no fuel expense whatever.

The increased safety in having two locomotives in trains of this sort on heavy grades can be appreciated.

In passenger service the delays and rough handling necessary to the operation with helpers is entirely eliminated. The same locomotive which may haul the train at 50 miles per hour can also handle it with ease and certainty on a 2.2 grade.

Here again the regenerative braking feature is important. One who has tried to sleep in a passenger train through mountain districts and has been kept awake by application of brakes at frequent intervals can readily appreciate the comfort of an electrically operated mountain trip in which it is impossible to tell from the way the train is handled as to whether a grade is being ascended or descended.

The smooth handling of passenger trains is a point of merit and occasions many favorable comments from passengers about our service.

The entire absence of cinders and a certain amount of grime from coal burning locomotives is appreciated by the passengers. Complaints of delays caused by poor fuel, engine not steaming and sundry things have become things of the past. We do have our troubles with electrical failures, it is true, but these are nearly all in a class not to be called serious and fortunately are uncommon.

Electric Switching

In electric switching service we find that the energy or fuel expense at the locomotive has been more than cut in two over steam operation. The locomotives are quick in acceleration, easy to handle and because the engineer has little to look out for other than the operation of starting and stopping, he can lend his whole attention to the business at hand and thus gets as much work done as the yardman can attend to.

The maintenance of these machines is slight and because of taking but little energy the extra demand for power that they require is not very noticeable at the substations which furnish it.

Wherever the trolley wire goes the electric locomotive has given particularly good results. In rerailing cars or engines or pushing snow plows the uniform rate of speed for a given load and the ease with which the locomotives can be controlled make their use decidedly advantageous.

The rated tractive effort of an electric locomotive is usually given as that within the continuous or 24-hour capacity of the traction motors. This is 72,000 lb. for our freight locomotives, but does not mean very much as compared to the maximum tractive effort which the locomotive can exert. This is only limited on these machines by the slipping point of the wheels. With sand used on the rail they have been known to exert a tractive force of 160,000 lb., and this could be maintained for a period of time until the tractive motors are in danger of overheating due to the large flow of current through them. Such tractive effort makes these machines efficient in handling cetrain work under adverse conditions.

Each Locomotive Its Own Dynamometer Car

Because the tractive effort is nearly proportional to the current flowing through the motors regardless of the speed, it is very easy to judge train weights, proper ratings and other things. In fact, every electric locomotive is equipped with its own instruments so that it is a very good dynamometer itself, and in cases where the engineer runs into conditions of overloading, he can readily judge the amount and reduce as necessary. There is no argument as to whether one man can get more out of an engine of this kind than another—they are all placed on an even basis. Moreover, the normal running times are so uniform that the dispatchers, as a general rule, do not have to figure much on the personal element of the enginemen in supervising train operations.

There are possibly other benefits to be derived from electrification, but I have endeavored to stay within the limitations applying to the locomotives alone. There are disadvantages too, of course, and there is a need for improvements and development changes as is true of all electrical equipment. However, the field for experiment and such changes is large, and with the successful electric motive power we now have, we have made the start, and further improved features can be inaugurated if necessary.

Welding Wire Specifications

The Report of the Committee on Welding Wire Specifications to the American Bureau of Welding has recently been distributed by the American Welding Society. The information is contained in Bulletin No. 2.

Those sections of the report which pertain exclusively to electrodes for arc welding have been abstracted and are as follows:

Abstract of the Report of the Committee on Welding Wire Specifications

Specifications

Bare Iron and Steel Electrodes.

(a) For welding mild steel, structural shapes, plates, bars, or low carbon steel forgings and castings.

(b) For welding high carbon steel and worn surfaces where great resistance to abrasive wear is desired and where machining is not necessary, such as rails, frogs, switch points, bearing surfaces, etc.

Folios

Coated or Covered Electrodes.

(a) For building up worn surfaces that require machine finish such as wheel flanges, axle collars, etc.

(b) For use on high carbon steels and worn surfaces where great resistance to abrasive wear is desired and where machinery is not necessary such as—rails, frogs, switch points, bearing surfaces, etc.

(c) For use on manganese crossing centers, frogs, switch points, dredging buckets, and other parts where an extremely hard tough surface is required.

The distinction between the specifications and folios are that the specifications are definite recommendations of the committee, which in accordance with the ruling of the bureau are to be valid for the period of one year, while the folios contain information which the committee offers solely as a guide for the selection of welding material of the nature described. The information in the folios must not be considered as direct recommendations as investigations have not been completed at this time, which would permit the preparation of specifications for this class of material.

The committee will continue in its search for further information and whenever definite results are obtained as to any particular electrode or welding rod, we will submit the same with recommendations as to its adoption.

Committee: D. C. Alexander, A. S. Kinsey, J. F. Lincoln, O. H. Eschholz, E. J. Wanamaker, W. J. Beck, H. G. Knox, C. J. Nyquist, J. W. Owens, H. L. Whittemore, J. Churchward, H. J. Horn, Hermann Lemp, S. W. Miller, H. I. Walsh, J. J. Flaherty, C. J. Holslag, C. A. McCune, Chairman.

Welding Specifications for Electrodes

Iron and Steel Bare

General:

1. The following specifications prefixed by the letter E are recommended for the purchase of all bare iron and steel electrodes for use in arc welding. The use of each particular type of electrode is specified below.

Scope:

2. The electrodes herein specified are recommended as covering the usual railroad, shipyard and industrial requirements as are allowed by authoritative regulating bodies, such as the American Bureau of Shipping, The Interstate Commerce Commission, etc.

Material:

3. Material made by the puddling process is not permitted.

Physical Properties:

4. Electrodes shall be made of commercially straight wire of uniform homogeneous structure, free from irregularities in surface hardness, segregation, oxides, pipe, seams, etc. Diameter shall not vary more than plus or minus 3 per cent from diameter specified.

Nomenclature:

5. The prefix letter E is to indicate that the material is intended for electric arc welding.

Chemical Composition:

6. The chemical composition of electrodes shall be within the following limits for uses specified:

Low Carbon Iron or Steel

E-No. 1A

Carbon	not over 0.06 of one per cent
Manganese	not over 0.15 of one per cent
Phosphorus	not over 0.04 of one per cent
Sulphur	not over 0.04 of one per cent
Silicon	not over 0.08 of one per cent

E-No. 1B

Carbon	0.13—0.18	of one per cent
Manganese	0.40—0.60	of one per cent
Phosphorus	not over 0.05	of one per cent
Sulphur	not over 0.04	of one per cent
Silicon	not over 0.06	of one per cent

The difference between E-No. 1A and E-No. 1B electrodes is one of chemical composition incident to manufacture only. In order to assure uniformity of product close limits are demanded. Either E-No. 1A or E-No. 1B may be supplied unless the purchaser, in ordering, specifically excludes either.

Medium Carbon Steel

The data at hand shows that Bare Steel Electrodes having a carbon content of .18 to .85 are of no particular value.

High Carbon Steel

E-No. 1C

Carbon	0.85—1.10	per cent
Manganese	0.30—0.60	of one per cent
Phosphorus, not over	0.04	of one per cent
Sulphur, not over	0.04	of one per cent

Recommended sizes:

7. E-No. 1A and E-No. 1B—1/16, 3/32, 1/8, 5/32, 3/16, 1/4 inch. dia.
   E-No. 1C—1/8, 5/32, 3/16, 7/32, 1/4, 9/32, 5/16 inch dia.

Uses:

8. E-No. 1A and E-No. 1B—For welding mild steel, structural shapes, plates, bars or low carbon steel forgings and castings.

E-No. 1C—For welding high carbon steel and worn surfaces where great resistance to abrasive wear is desired and where machining is not necessary, such as rails, frogs, switch points, bearing surfaces, etc.

9. The surface shall be smooth and free from rust, oil or grease.

Tests:

10. In the hands of an experienced welder electrodes shall demonstrate good weldability in "flat" and "overhead" positions and shall pass through the arc smoothly and evenly without any unusual characteristics.

Packing:

11. Electrodes shall be delivered in coils or in straight 14-inch lengths, packed and wrapped as follows:

(a) Bundles of 50 lb. net weight, securely wired and wrapped in heavy weatherproof paper.

(b) Bundles of 50 lb. net weight, securely wrapped in heavy burlap.

(c) Boxes or kegs of 100, 200 or 300 lb. net weight, and wrapped as per paragraph (a).

(d) Boxes or kegs of 100, 200 or 300 lb. net weight and wrapped as per paragraph (b).

(e) Coils of approximately 50 or 100 lb. net weight, and wrapped as per paragraph (a) or (b).

Marking:

12. All bundles, coils, boxes or kegs shall be provided with a metal, linen or strong fibre tag securely wired to or in the case of boxes or kegs, nailed on the outside, bearing the following information:

Make ....
Specif. No. ....
Dia. ....
Nom. Weight ....

Ordering:

13. Material ordered under these specifications shall be known as:

"Electrodes, iron and steel, bare," American Welding Society Specifications Number 1, Revised May 1, 1921.

All orders should be specified in pounds. In addition, requisitions shall show the following:

Specif. No.
Size
Packing

As a guide in ordering, the following information is of use:

Size, inches ..	1/16	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16
Lbs. per 100 ft.	1.04	2.3	4.1	6.5	9.3	12.76	16.7	21.0	26.0
Ft. per 100 lbs.	9615	4273	2403	1537	1067	700	600	473	383
Mills	63	94	125	156	188	218	250	281	312

Coated Electrode Folio No. 1-E

CHEMICAL ANALYSIS OF COATED OR COVERED ELECTRODES

General:

Coated and covered electrodes have a distinct field in arc welding, but the Welding Wire Specification Committee is not prepared to recommend any chemical analysis of material, forms of coating or covering.

The data contained herein is the result of investigation by the committee to date and is offered solely as a guide for the selection of welding material of the nature described.

This folio must not be considered a direct recommendation as investigations have not been completed at this time which would permit the preparation of specifications for this class of material.

Coated and covered electrodes afford a broad field for research and specifications will be prepared for such electrodes as determined.

Sizes:

1/8, 5/32, 3/16. 1/4, 9/32 and 5/16 inch diameters.

Chemical Composition:

The chemical composition shall be within the following limits for the uses specified:

LOW CARBON IRON OR STEEL

No. 1

Carbon ....not over 0.06 of one per cent
Manganese ....not over 0.15 of one per cent
Phosphorus ....not over 0.04 of one per cent
Sulphur ....not over 0.04 of one per cent
Silicon ....not over 0.08 of one per cent

No. 2

Carbon ....0.13—0.18 of one per cent
Manganese ....0.40—0.60 of one per cent
Phosphorus ....not over 0.04 of one per cent
Sulphur ....not over 0.04 of one per cent
Silicon ....not over 0.06 of one per cent

Uses:

For welding mild steel, structural shapes, plates, bars or low carbon steel forgings and castings.

MEDIUM CARBON STEEL

Carbon ....0.25—0.35 of one per cent
Manganese ....0.30—0.60 of one per cent
Phosphorus ....(under) 0.04 of one per cent
Sulphur ....(under) 0.04 of one per cent
Silicon ....(under) 0.12 of one per cent

Uses:

Building up worn surfaces that require machine finish, such as Wheel Flanges, Axle Collars, Etc.

HIGH CARBON STEEL

No. 1

Carbon ....0.60—0.75
Manganese ....0.60—0.90
Phosphorus ....not over 0.04
Sulphur ....not over 0.04

No. 2

Carbon ....0.85—1.10
Manganese ....0.30—0.60
Phosphorus ....not over 0.04
Sulphur ....not over 0.04

Uses:

For use on high carbon steels and worn surfaces where great resistance to abrasive wear is desired and where machining is not necessary, such as rails, frogs, switch point, bearing surfaces, etc.

MANGANESE STEEL

Carbon .... 1.10 — 1.35 per cent
Manganese ....11.00 —14.00 per cent
Phosphorus .... .017— .04 of one per cent
Sulphur .... .007— .04 of one per cent
Silicon .... .10 — .20 of one per cent

Uses:

Manganese Crossing Centers, frogs, switch points, dredge buckets, and other parts where an extremely hard tough surface is required.

CAST IRON

There is not sufficient data on an electrode of cast iron analysis. Therefore, the chemical composition as given for low carbon iron and steel will govern for the present.

Uses:

Cast Iron parts studded or general welding.

Notes:

All non-ferrous electrodes are being investigated and folio will be issued when sufficient data has been secured.

Objections to Installing Automatic Stops

The committee appointed by the railroads affected by the Interstate Commerce Commission's order of January 10, 1922, calling for the installation of automatic train control devices, presented a memorandum at the hearing before the Commission in Washington on March 20, rehearsing the objections to the issuance of a positive order by the Commission at the present time and classifying them under four heads, as set forth below; and also presented other statements, prepared by Messrs. Burt and Peabody, containing the results of investigations made by the committee. This committee consists of C. E. Denny, B. R. Pollock, A. M. Burt, W. P. Wiltsee, E. B. Katte, R. W. Bell, C. F. Giles, W. J. Eck and C. H. Morrison.

1. No automatic train stop or train control device has been sufficiently developed to justify the issuance of the proposed order. That the state of the art as is existed up to the beginning of the year 1920 did not warrant any extended use of the devices in question is, we submit, not open to debate. The Committee of the United States Railroad Administration (1919) summarized the situation thus:

"Generally speaking, it may be said that the tests which have thus far been conducted have demonstrated that the functions of automatic train control devices are possible of accomplishment under actual service conditions. But while these functions may be accomplished at comparatively isolated locations with the high degree of maintenance ordinarily given to test installations of this character, it is an entirely different problem, and a far more complex one, to apply these devices to the various operating conditions encountered in railroad service * * * on several hundred miles of a busy railroad. * * * Automatic train control devices are still in the development stage, and many problems in connection with their practical application remain to be solved."

These views are consonant with those of the Block Signal and Train Control Board (June 29, 1912), also with the reports of the Commission's Bureau of Safety. While progress has been made during the past two years, it is still true that *many problems in connection with practical operation remain to be solved*.

The only systems which have been in service under actual operating conditions and dependable and continuous observation for any considerable length of time, are those of the Regan, the Miller and the American, now in service to a limited extent on the Rock Island, the C. & E. I., and the C. & O. These three are the only installations of which specific mention is made in the Commission's report of January 10, 1922, which, we submit, warrants the inference that the Commission had them in mind when it said that "14 years of investigation have demonstrated the practicability of and the necessity for automatic train control." In any event, the failure of the Commission, in its report, to direct attention to any other particular installation, must lead to the conclusion that in the judgment of the Commission no other system of train stop or train control has been sufficiently tried out to warrant even the suggestion that it be generally adopted.

The three installations above referred to have been the subject of special investigations conducted by a subcommittee of the Joint Committee on Automatic Train Control of the American Railway Association. The report of such committee shows, among other things, with respect to each of the devices in question:

(*a*) Numerous objectionable mechanical and engineering features remaining to be corrected;

(*b*) Many operating difficulties which have not yet been satisfactorily taken care of;

(*c*) A relatively large number of failures.

In short, this report conclusively establishes not only that the devices in question have not yet been brought up to the point where it can be said that they show a "high degree of efficiency" under general service conditions, but also that they, like all other kindred devices, are still in the experimental or development stage and that many problems remain to be solved before they can be considered as practicable and reliable for the purposes of the Commission's proposed order.

We are dealing with a very different proposition from that of the automatic coupler, the air brake or the block signal.

The Commission's observation to the effect that the automatic coupler, the air brake and the automatic block signal were not perfected to as high a degree as the automatic train control before they were either ordered installed or were voluntarily adopted, appears to be at a variance with the facts.

The records of the Master Car Builders' Association show that the automatic freight car coupler was a subject of discussion and experimentation from 1870 to 1887, a period of 17 years, before it was adopted by the association as recommended practice. It was six years later than this before its use was required by law. Prior to its requirement by law it was a well recognized safety device.

The air brake was a subject of discussion and experimentation from 1870 to 1888, a period of 18 years, before it was adopted as recommended practice, and it was 23 years before it was required by law; then it was a safety device recognized by all of the more progressive railroads of the country.

Automatic block signals had reached a much higher degree of development than train control devices have at present before any such extensive installations were made as is contemplated in the proposed order, and the installation of automatic block systems was a much simpler matter than the installations of automatic train control devices. With an automatic train control system no engines can be operated under it except those equipped with a device that will function in conjunction with the system installed upon the roadway. The adoption of the automatic coupler and air brake did not affect the capacity of a railroad; their practicability had been demonstrated beyond a reasonable doubt before their use was required by law.

2. The order would be premature if issued at this time because the carriers have not had opportunity to make adequate service tests of devices designed to function on different principles from the devices specifically mentioned in the Commission's report. Each of the three systems specifically mentioned in the Commission's report is so designed as to require the use of a ramp located alongside or between the rails.

Efforts are now being made to develop automatic train control devices designed to function on the induction principle, and it is the opinion of the engineering and operating officers of numerous carriers that such type gives promise of overcoming many of the objectionable features inherent in the ramp type. Train control systems designed to operate on the induction principle have lately been installed or are contemplated in the immediate future, viz.: the Sprague, the Bostwick and the Union Switch & Signal devices. These appear to possess merit and the result of the tests may warrant their extension. No order, therefore, should be issued until such time as the carriers have had ample opportunity to ascertain whether or not some one or more of such systems is practicable and reliable for the purposes of the Commission's order.

3. The carriers are making every reasonable effort to co-operate with the Commission in testing all meritorious devices and will continue such efforts as the Commission may direct.

In view of the activities of this committee since its appointment in November, 1920, as disclosed by this report, it would appear that the issuance of the proposed order, which cannot now be complied with, will tend to retard rather than promote the development of a proper system. The committee as well as the individual carriers will continue to render all reasonable assistance in the proper testing and development of these devices.

4. The proposed order requires a much greater number of and more extensive installations than are warranted at the present time.

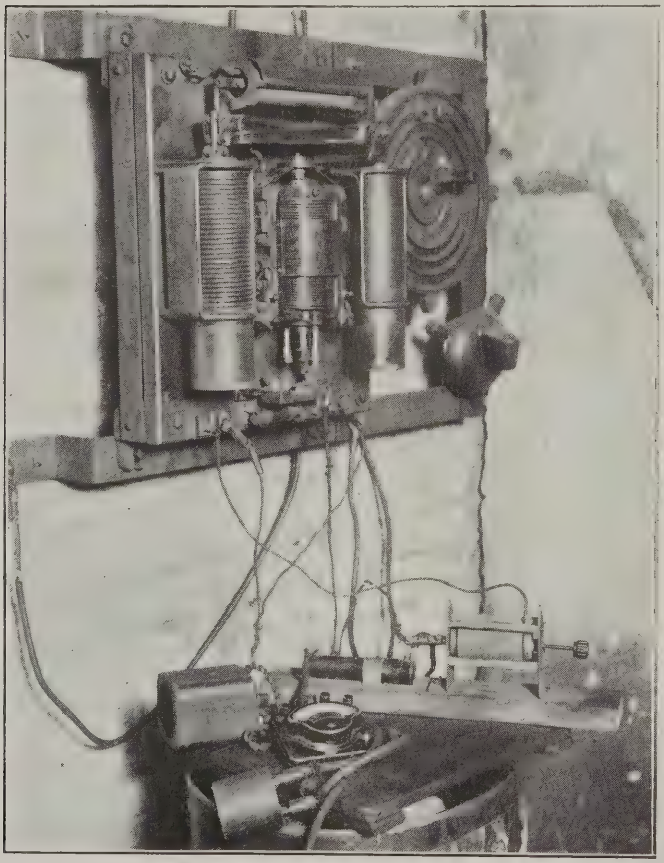
Answers by all carriers named in the order of January 10 except the Pennsylvania, the Pittsburgh, Cincinnati, Chicago & St. Louis and the West Jersey & Seashore companies, to a questionnaire submitted by this committee, indicate that compliance with the proposed order by the carriers answering the questionnaire (46 in number) will require the installation of the devices in question on approximately 6,126 miles of railroad, 10,285 miles of track and 5,525 locomotives, the cost of which will aggregate many millions.

It is manifest that such systems as recommend themselves to the Commission can be just as thoroughly tried out by continued co-operation between the Commission and the American Railway Association along the lines heretofore followed, as can be done by the extensive installations contemplated by the proposed order, which would require the expenditure of vast sums of money unnecessarily.

Testing Equipment for Controller Panels

A convenient method of testing and adjusting car lighting controller panels is in use in the coach yard of the Chicago & Western Indiana at Chicago. The method is a time saver and should find application in other coach yards where it is necessary to test controller panels.

Passenger equipment belonging to several different roads is turned in the Chicago coach yard of the Chicago



Controller Panel Mounted On Frame in Shop for Testing

& Western Indiana. This equipment comes under the supervision of the Western Indiana electrical department, and in addition to this the electrical department does all of the maintenance work on the car lighting equipment of one of the smaller roads. Every effort is made to confine maintenance work to the yard, as no provision is made for the men to ride the cars in service. This makes it necessary to provide a means for testing and adjusting controller panels on cars.

To provide this means, a frame of ½ in. by 2 in. strap iron was mounted on the wall in one corner of the shop. This frame was drilled so that controller panels can be attached conveniently. The yard circuits are so arranged that the batteries on two cars can be connected in series and the circuit brought in to the testing panel. A small carbon pile rheostat, shown in the illustration is connected in series with the battery power circuit brought in from the cars in the yard and is used to adjust the voltage to the pickup and cut out operating voltages of the panel. A water rheostat made of a rubber battery jar forms the load. Portable meters are utilized for this test.

This testing equipment is, of course, readily operated in the car and it is not necessary to bring the controller panel into the shop. When the testing equipment is placed in the car, the water rheostat is carried to the car or the lamps in the car are used as the load. The apparatus is simple and easily constructed and can be made up from material which is available in practically any coach yard.

A Handy Rack for Drill Bits

Drill bits of various sizes are difficult to find when allowed to be kept helter-skelter or thrown on benches and in drawers. This also tends to nick the bits and dull them. A handy case where drill bits can be kept in an upright position and separate from each other is very desirable. A simple rack of this kind has been made from a piece of 2-in. by 4-in. lumber of the required length to hold the number of bits. Placing the 2-in. by 4-in. on edge a hole, the proper size and depth, is bored for each bit. It is a good plan to stencil the size of each bit opposite the hole. Such a rack has saved considerable time for the bit wanted was always in the bottom of the box.

Lubricating Steam Pipe Lines

An excellent condition of steam pipe lines may be maintained by placing a lubricator in the boiler room, and feeding a small quantity of cylinder oil into the line. There is absolutely no doubt that this expedient saves much loss at comparatively small cost. The feeding of oil tends to prevent corrosion, thereby preserving the threads of the piping, and keeps the gaskets at the joints soft, so that they do not crack and burn out. Steam lines treated in this way will last indefinitely, and stay tight.

The hardest man in the world is the man who is afraid to own up when he is mistaken.

You Can't Beat 'Em

An Irishman came into the office of the president of the Illinois Central Railroad and said:

"Me name's Casey. Oi worruk out in the yar-rds. Oi'd loik a pass to St. Louis."

"That is no way to ask for a pass," said the president. "You should introduce yourself politely. Come back in an hour and try it again."

At the end of the hour back came the Irishman. Doffing his hat he inquired, "Are yez the man I saw before?"

"I am."

"Me name is Patrick Casey. Oi've been workin' out in the yar-rds."

"Glad to know you, Mr. Casey. What can I do for you?"

"Oi've got a job an' a pass to St. Louis on th' Wabash. Yez can go to blazes."—*Case Eagle.*

Are You—

Cool-headed, quick-witted and thoughtful?
Interested in your work?
Considerate of your fellow employees, particularly those working under you?
Honest in your dealings with your employer and faithful in protecting his interests?
Cheerful in performing your duties to the best of your ability?
Loyal to your company and jealous of your reputation?
Watchful, so that you may meet an emergency as it arises?
THEN—
You're a regular railroad man!
—*C. & O. R. R. Employees' Magazine.*

Always Tell the Last Story

Rastus from Boston was trying to impress his Southern cousin with the superior speed of Northern trains.

"When dat ole Montreal express gets to hummin', Mose," he asseverated solemnly, "de telegraph posts looks like slats on a chicken fence."

"Humpf!" sniffed Mose. "When de Southern express steps out foe' Noo Orleans, it nacherally makes de mileposts look closer'n strings on a banjo."

How to Get Poor

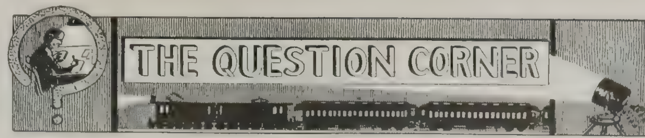
Now, having all become immensely successful by following formulas previously published, we prescribe an antidote. This is our "Sure Cure for Success," or "How to Get Poor," viz.:

1. Don't work regularly. It tends to increase one's bank account.

2. Tell the boss what you think of him and his family. It promotes action and you'll land in the street.

3. Knock the company. That's one of the best ways to gum things up.

4. For heaven's sake don't save your money. Spend it on silk shirts and doo-dabs. Then everybody will make silk shirts and the price of necessities will rise to the skies. And what is better than having cheap luxuries and expensive flour?



Answers to Last Month's Questions

1. What would be the cause of plates of a storage battery breaking away from the connector straps as shown in Fig. 1? In the case on hand a Williard cell,

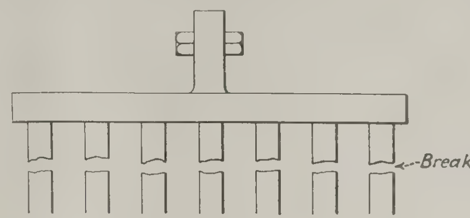


Fig. 1

300 amp. hrs., gravity tested at 1180-voltage, 1.9, plates broken away from negative strap; positive O. K. Electrolyte normal height. Three cells in the same set went this way at different times.—A. H. M.

* * *

1. In answer to the question of A. H. M. concerning the broken battery plates, it is my opinion that the plates were not properly secured to the strap. I have known of some instances where plates were moulded to the strap and which broke away in this manner. Had the trouble been with the positive set rather than with the negative set, I should say that it was caused by the end plates of the set growing to such an extent as to lift the plates in the center from the rest, thereby causing them to swing freely. Under these conditions the movement of the car might cause the plates to break off. However, since the trouble occurred with the negative set, the only reason that I can see is that they were improperly secured to the strap.—G. W.

* * *

1. In reference to the question which appears on page 105 of the March issue of the *Railway Electrical Engineer*, I can give but one reason for such a failure and that is a poor job of lead burning. The plates were no doubt not properly burned to the bridge. I know of one instance where such a failure was due to the plates being soldered to the bridge. In burning the plates to the bridge, nothing should be used but a hot flame and soft strip lead.—C. W. T. S.

* * *

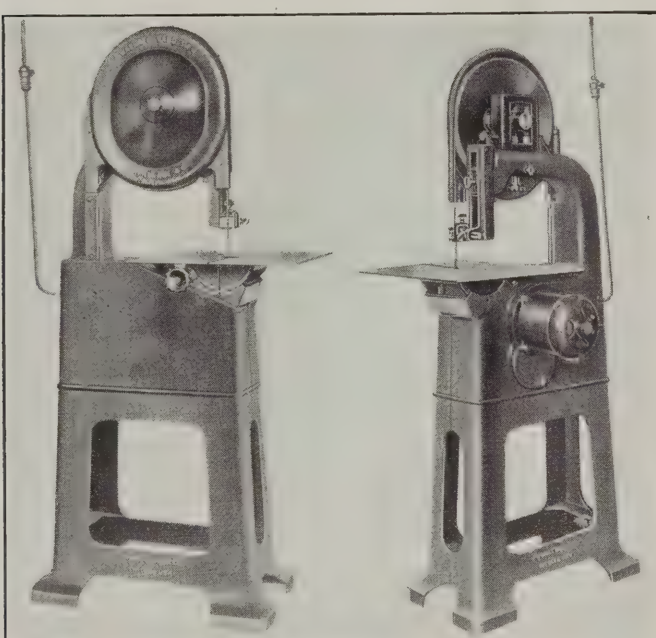
Questions for April

1. The copper loss in a line is 36,000 watts, and there are four consumers on this circuit, each requiring 3,000 watts; (a) would the 3,000 watts consumed by each of them be included in the 36,000 and be considered as consumed by the conductors, or would this be additional power to be furnished by the power house? (b) If the voltage of the circuit was increased from 600 to 1,200 volts, with 60 amperes and the line resistance 20 ohms, would this increase in voltage burn out the apparatus if the wiring was of proper size to carry 60 amperes? (c) Then, is it the increase in current and not voltage which would cause this trouble if the wire was of correct size to carry current?—C. R. E.

NEW DEVICES

Sixteen Inch Motor-Driven Band Saw

A band saw driven by a self-contained electric motor has been placed on the market recently by J. T. Wallace & Company, Chicago. This saw is equipped with disc steel wheels which are both durable and accurate and have a large factor of safety. Ball bearings are provided throughout including the upper and lower roller guides, the saw bearing on the periphery of the rollers. A special feature is the totally enclosed electric motor, built into the machine and direct-connected to the lower wheel by a fabroil gear and steel pinion. The gears run in oil to insure adequate lubrication and a quiet running machine, centrifugal force throwing oil into the bearings and keeping them well lubricated at all times.



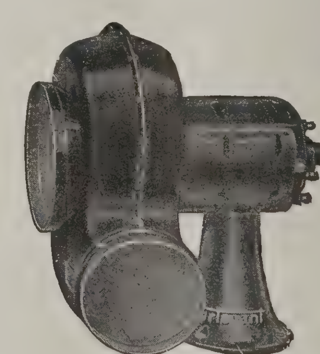
16-In. Wallace Band Saw With Direct Motor Drive

The saw table is a ground steel plate 19 in. by 21 in. in size, mounted on a large rocker bearing adjustable to any angle from 45 deg. to minus 5 deg. An indicator is provided to show the angle at which the table is tilted. All adjustments are controlled by hand-wheels or thumb screws without the use of special tools, and this feature is one of considerable importance because it makes the machine easy to handle and increases the production.

The height of the new 16-in. Wallace bench band saw is 5 ft. 9 in. overall; the table is 42 in. from the floor; and the floor space required is 15 in. by 29 in. Power is furnished by a ½-h.p. General Electric ball-bearing motor running at 1,750 r.p.m. The saw runs at 3,150 ft. per min. Safety guards are built into the machine and are a standard part of it. The blades used are especially made for this machine, being treated and cut so as to provide the greatest number of producing hours on this size of wheel.

Locomotive Cab Ventilating Set

The problem of locomotive cab ventilation is a more or less serious one, especially on roads where steam locomotives are required to operate in tunnels. An unusually interesting method of solving this problem has been developed by the B. F. Sturtevant Company, Boston, Mass., the essential part of the apparatus being the ventilating set illustrated. These sets have been applied in one case to the locomotive cabs of Mallet locomotives operating in districts where tunnel clearances are close and the grade adverse to the movement of trains. According to a prominent officer on the road in question the transfer of Mallet locomotives to one of the branch lines where the conditions described above existed resulted in forcing attention to the problem of locomotive cab ventilation. Experiments were conducted in an effort to provide better ventilation and it was found by using the Sturtevant



Sturtevant Cab Ventilating Unit

electrically-driven ventilating sets, two units to the locomotive, the atmospheric conditions in the cab could be materially improved.

The ventilating sets were operated electrically by an electric headlight turbo-generator installed for the purpose. Two sets were applied to the locomotive, located under the boiler ahead of the firebox. The intake from the fan gathered the air at a point about 6 in. above the track. One fan delivered air to the right side of the locomotive immediately in front of the engineman and the other to the left side. In order to get the best results, it was found necessary to make the cab as nearly airtight as possible so that the fresh air delivery inside the cab would create a pressure in excess of that surrounding the cab, thus preventing the foul gases from entering.

Sturtevant portable ready-to-run ventilating sets are made in five sizes running at speeds up to 3,400 r.p.m. and delivering from 58 to 1,440 cu. ft. of free air per min., depending upon the size.

Crane Truck and Charging Plug

The Elwell-Parker Electric Company, Cleveland, Ohio, has recently developed an electric truck with a carrying capacity of 3,000 lb. and revolving counterbalanced crane of unusual length. The crane is a handy, portable device for hanging smoke box doors, or air pumps on locomotives in shops or engine houses. It is also adaptable

Fig. 1—Elwell-Parker Truck with 8-Ft. Outreach Power Crane

to use in storerooms to handle castings, lighting generators and other parts which can be safely and easily stacked, reducing the storage space usually required.

The heavy vertical steel column, shown in Fig. 1, has a long bearing in a pedestal bolted to the steel platform on the truck, and supports a 12-ft. boom which may be racked in or out by the operator without leaving the driving position. The hoist is operated by a separate motor direct-connected to an enclosed hoist mechanism. The controller is located on the dash in front of the crane operator. The hoist is mounted on a steel frame which houses the battery, the battery, hoist and motor all acting as a counterbalance. A special trip switch mounted on the front of battery box stops the inward motion of the boom as set.

The crane is designed to pick up 1,000 lb. at an 8-ft. out-reach, or with outriggers in position as shown 3,000 lb. at 6-ft. outreach. The boom may be lowered to permit entrance of doorways. The outriggers are quickly adjusted, folded and swung in beside the crane column when not in use.

The truck is equipped with 21½-in. by 3½-in. drive wheels and 15-in. by 3½-in trailing wheels, all four of which steer. Large wheels permit use in yards. A coupler is furnished on the rear to permit using the unit for intermittent tractor service. Motors, differential worms, wheels and crane pillar column are all fitted with

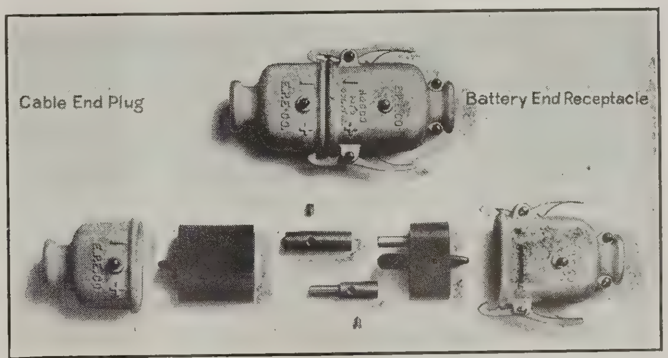


Fig. 2—Improved Battery Charging Receptacle and Plug

ball bearings. A single battery furnishes power to propel the truck as well as to operate the crane.

One of the smaller though important details of a truck is the attachment or charging plug. Every battery is equipped with the receptacle or battery end of this plug and interchangeability is one of the factors of prime importance.

The Elwell-Parker Electric Company has recently made improvements in these charging plugs, as shown in Fig. 2, without interfering in any way with their interchangeability.

The new charging plug shells or cases are equipped with latches for holding the two halves rigidly together while the truck is in motion. The addition of these latches prevents bending or loosening of the telescoping terminals with consequent advantage of avoiding destructive burning or arcing.

Moulded Bakelite insulation is used in making up the inserts. The terminals are removable and are held in place by filister head screws, so that terminals can be furnished separately, for use in an old insert. Wires are soldered into the terminals, thus forming a perfect electrical connection, whereas previously wires have been clamped in place by machine screws and connections sooner or later come loose, causing heating and arcing. This heat was transmitted to the telescoping end of terminals, thus effecting the current carrying capacity of the plug as a whole. New inserts can be used in old shells, thus assuring interchangeability.

General News Section

The Westinghouse Electric & Manufacturing Company has separated the power and railway divisions of the Pittsburgh office. Barton Steveson, who has been manager of both divisions, will continue as manager of the power division and F. G. Hickling has been appointed manager of the railway division; S. R. Shave has been appointed manager of the price section of both the power and railway divisions in the Pittsburgh office.

The Weston Elec. Inst. Co., Newark, N. J., announces the appointment of the following sales representatives: Shiefer Electric Co., Inc., with offices at Rochester, Buffalo and Syracuse for upper New York State and Erie, Pa. L. D. Joralemon, Otis Bldg., Philadelphia, Pa., for Pennsylvania, Delaware, Maryland and District of Columbia. Warren C. Graham Co., Carondelet Bldg., New Orleans, La., for Louisiana, Mississippi and Lower Alabama.

The Air Reduction Sales Company, New York, on March 17, acquired all the assets, including the patents, trade marks and trade names of the Davis-Bournonville Company of Jersey City, N. J. The consolidation brings together two large companies, whose histories have, to a great extent, been the history of the development of the oxyacetylene welding and cutting industry. Equipment will be marketed under the trade name of Airco-Davis-Bournonville.

The Appleton Electric Company, Chicago, manufacturers of conduit fittings, lighting and other electrical specialties, announce that R. P. Tillotson, who has been associated with the company for the past 13 years as western sales manager and director, will take charge of the California territory, in which they were formerly represented by Keeler, White Company of San Francisco. Branch office and warehouse will be maintained in Los Angeles. Arthur S. Merrill, formerly sales manager for the Chicago Fuse Mfg. Company and who is well-known to the electrical trade, will be general sales manager, with headquarters at Chicago office.

Turbo-Electric Locomotive Being Tried in England

Trials are being made on the London & North Western railway, England, of a turbo-electric locomotive constructed by Messrs. Armstrong Whitworth & Co. for the Ramsay Condensing Locomotive Company. The engine has a length overall of 69 ft. 7 in. and weighs 130¾ tons, including coal and water. The boiler which is in front, generates steam at 200-lb. pressure and 300 deg. F. superheat. The main three phase turbo-alternator and the auxiliary exciting turbo-generator are also in the front. The current is taken to four 275 h.p. electric motors, two of which drive the wheels of the front part and two those of the back part or tender. The exhaust steam is conducted to the tender, where it is condensed in a condenser of special construction. The hot condensed water returns to the hot well and thence to the boiler. The object sought is economy of coal and water.

Electrical Standarization in England

Owing to the inability of the companies which form the proposed Southern group of English railways, namely the London & South Western, the London, Brighton & South Coast and the South Eastern & Chatham to agree to some form of uniformity in future plans for the electrification of these lines, the Minister of Transport has appointed a committee under an independent chairman to consider this matter. The committee consists of nominees of the respective companies under the chairmanship of Sir Philip Nash. Other members include Sir Alexander B. W. Kennedy, formerly chairman of the Electrification of Railways Advisory Committee, Sir Philip Dawson, and Theodore Stevens, M. I. C. E., consulting electrical engineer.

Equipment Program of the St. Louis-San Francisco

The St. Louis-San Francisco has authorized the expenditure of $7,766,000 in 1922 for new equipment, the repair and improvement of old equipment and other improvements; included in the amount is $1,260,000 for 8 steel coaches 6 steel chair cars and a 150-ton steam derrick; $360,000, for rebuilding 250 steel coal cars; $300,000 for rebuilding 9 locomotives; $1,431,000 for bettering existing equipment; $205,000 for new power plants; $35,000 for new water treating plants; and $87,500 for improvement of coaches in branch line service. All mail and mail apartment cars are to be entirely rebuilt; baggage cars are to be improved; 7,000 freight cars rebuilt; 1,150 furniture and vehicle cars to be improved; and electric lights to be installed in coaches on branch lines and steel under-frames to be placed in all wooden coaches.

Illinois Central Electrification

Announcement has been made that President C. H. Markham of the Illinois Central Railroad, will present a proposition to the stockholders on April 19, involving authorization of an issue of $50,000,000 preferred stock to be sold at various times as needed in the work of electrifying the lines in Chicago and constructing new freight and passenger facilities. The Illinois Central entered into a contract ordinance passed by city of Chicago on July 21, 1919, whereby it agreed to begin electrification of the lines within the city within five years and to complete this work within five years more.

Since the contract ordinance was entered into, the company has been doing a great deal of work leading up to the decision as to the system of electrification which will be used and bearing on the many correlated problems in-

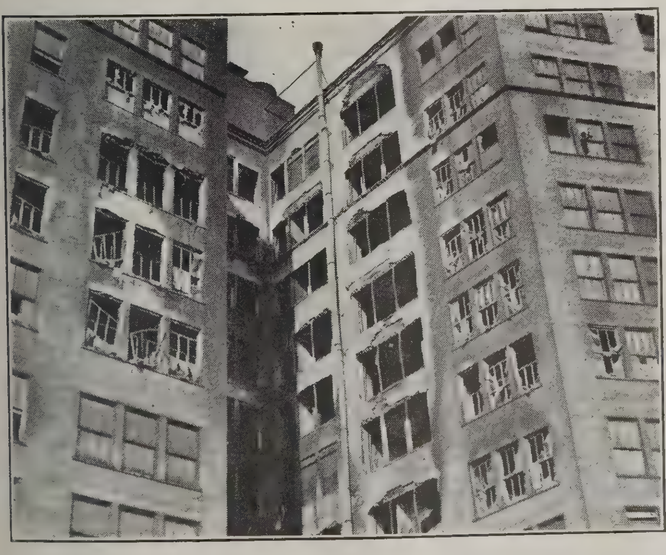
volved in the very extensive improvement of the whole lake shore area occupied by the railroad. No decision has been reached as yet as to the system of electrification, but it is expected that an announcement will be forthcoming in the near future. The financial plan, as proposed, will be such as to enable the directors to take advantage of market conditions in disposing of the preferred stock of the company.

Atlantic City Conventions in June

Steady progress is being made in developing the programs for the June conventions which will be held at Atlantic City. Division V, Mechanical, A. R. A., will meet from June 14 to 21 inclusive. Division VI, Purchases and Stores, A. R. A., will hold its meeting on June 19, 20 and 21. The Association of Railway Electrical Engineers will hold its spring meeting at the Dennis Hotel on Monday, June 19. The exhibit committee of the railway Supply Manufacturers' Association met at Pittsburgh yesterday afternoon to assign space to those who have already made applications. Up to March 1, 240 such applications had been received, requiring in the neighborhood of 80,000 sq. ft. of space. A particularly large number of machine tool companies have applied for space in Machinery Hall, and all of the space in this section has been applied for.

Burlington General Offices at Chicago Damaged by Fire

The 15-story office building of the Chicago, Burlington & Quincy, at Clinton street and Jackson boulevard, Chicago, was visited by a desastrous fire early on the morning of March 15. The contents of the upper seven floors of the building were entirely destroyed and considerable damage was done on the lower floors by water. The office is a modern fireproof building and the damage



Copyright by Underwood & Underwood

View of the Upper Seven Floors from the Court

was caused by the burning of adjacent buildings. The heat from the outside fire separated from the Burlington building only by the width of Clinton street, 80 feet, and driven by a strong east wind drove all of the fire fighters below the ninth floor.

The office of J. E. Gardner, electrical engineer, was located on the 14th floor and all of his office furniture, correspondence files, drawings, tracing and records are gone. His library of technical literature, magazines and catalogs were also burned.

The conduit and wiring of the top seven floors must practically all be replaced. Considering the extensive damage to the wiring, switches and fixtures on the upper seven floors, it is expected that a contract will be let under the direction and supervision of the electrical department for a complete new system. At the present time the electrical department is kept busy replacing switches and furnishing lighting service to the various offices located temporarily on the lower floors and in various buildings in the vicinity.

Personals

J. P. Puette has been appointed supervisor of electric appliances, New York Central, lines west of Buffalo, with headquarters at Cleveland, Ohio. Mr. Puette was born on a farm near Lenoir, N. C., and was educated in public and private schools of that section. The first work he did away from home was with the Asheville Street Railway Company, Asheville, N. C. He remained with this company for a period of two years, 1896-1897. The next two years were spent with the Whiting Lumber Company, Elizabethtown, Tenn., and the following year and a half, 1900-1902, with the Pittsburgh Railway Company, Pittsburgh, Pa. The following year he was in the employ of the Variety Iron & Steel Company, Cleveland, Ohio.

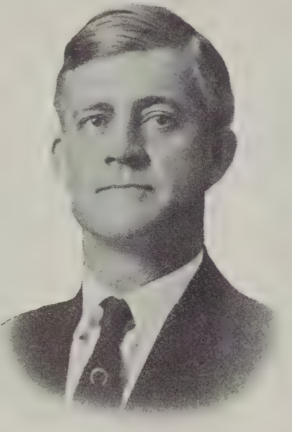
J. P. Puette

In the fall of 1903, Mr. Puette took a job as electrician with the Lake Shore & Michigan Southern Railroad Company, now the New York Central, at Collinwood and held this position until January, 1908, at which time he was transferred to Root street, Chicago, Ill., as foreman electrician car lighting, holding this position until May, 1910, when he was transferred to Collinwood, Ohio, as general foreman electrician car lighting.

In February, 1913, he was transferred to the General Office Building Cleveland, Ohio, as assistant to Mr. H. C. Meloy, supervisor of electrical appliances, and remained his assistant until his death on October 13, 1921, at which time Mr. Puette took up the work formerly done by Mr. Meloy.

E. B. Katte, chief engineer, electric traction, New York Central Railroad, has been appointed representative of the American Railway Association on the sectional committee of American Engineering Standards Committee for Standardization of symbols for electrical equipment of buildings and ships.

R. C. Haley, salesman and inspector for the United States Light & Heating Corporation, resigned, effective March 10, to accept the position of sales engineer with the Edison Storage Battery Company with headquarters in its new office in the Railway Exchange Bldg., St. Louis. Mr. Haley will have charge of sales and service for the car lighting, signaling and industrial trucks in the central Southern territory of the railway department. Mr. Haley entered the railway electrical field in 1899 with the Wagner Electrical Company in St. Louis and in 1902 became associated with the Consolidated Electric Lighting and Equipment Company, N. Y. In 1906 when the Missouri Pacific equipped a number of its cars with axle lighting equipment, Mr. Haley was appointed assistant chief electrician of this road. Later he was connected with the electrical department of the St. Louis-San Francisco for a short time and in 1907 returned to the Consolidated Railway Electric Lighting and Equipment Company. The latter part of this year he entered the service of the Bliss Electric Car Lighting Company at Milwaukee. A few years later this organization was merged into the present United States Light & Heating Corporation and Mr. Haley was appointed salesman and inspector, which position he held until his recent appointment.



R. C. Haley

William J. Clark, pioneer in the commercial development of electric railways in the United States and a member of the staff of the General Electric Company for 34 years, has been appointed advisory manager of the railway department. Mr. Clark has been manager of both the railway and foreign departments of the General Electric Company, managing director of the British Thomson-Houston Electric Company, manager, Cincinnati, and office manager of the London office of the General Electric Company, as well as holding other positions of importance. He was born in Derby, Conn., in 1854.

Mr. Clark, who joined the Thomson-Houston Company in 1888, originated the project and was instrumental in obtaining the legislative charter authorizing the constructon of the first electric railway in the world intended for freight traffic at Derby and Ansonia, Conn. Acting upon the advice of the late William Wallace, pioneer of arc lighting and motor production, and attracted by the possibilities presented by electric traction for the betterment and expansion of local transportation facilities, Mr. Clark entered the electric field and participated in the commercial expansion of almost every phase of the Thomson-Houston and General Electric Companies' business throughout the world.

In the spring of 1888, he induced the Thomson-Houston Company to purchase the Vandepoele Electric Railway patents, which from a patent standpoint were essential to the fullest possible development of that industry. He early recognized the value of certain fundamental patented electrical inventions, and was an active worker in bringing these under the control of the corporate interests he represented.

Mr. Clark played an important part in the commercial exploitation of the Vandepoele patents; Potter's Series Parallel Control; Sprague's Multiple Unit Train Control; Curtis' Steam Turbine and other inventions. In 1896, at Milwaukee, Mr. Clark made the first computation in this country of what is now termed "Physical Valuations" of a large electric public utility.

In 1908, he was expert on Cuban affairs for the War Department. In 1906 and 1907 he was chairman of the Ways and Means Committee of the National Civic Federation, in which connection he financed the extensive investigations of municipal ownership conducted by the Federation in this country and in Europe and he was also a member of the Commission which had charge of the investigation.

Mr. Clark is a member of many electrical and railway engineering societies of the country. He makes his headquarters at the New York Office of the General Electric Company, 120 Broadway.

The duties of his new position as indicated by its title will be entirely advisory.

Trade Publications

The Chicago Fuse Mfg. Co., of Chicago, has just issued a new catalog on electrical protecting materials and conduit fittings. This catalog contains 96 pages with 445 illustrations. It contains valuable information for everyone interested in such electrical devices.

Electric Headlights—The Pyle National Company, Chicago, has recently issued an 8½-in. by 11-in., 22-page illustrated catalogue, No. 101, describing this company's line of electric lighting equipment and accessories for locomotives, railway shops and yards. Sectional views are given to show the construction, adjustment and maintenance of head lights, turbo-generators, flood light units and switches. Diagrams of the complete circuits for locomotives are given together with lists of material and directions for installation.

Westinghouse Electrification Data, Vol. III, No. 2, is a new publication just produced by the Westinghouse Electric & Manufacturing Company. In this issue the foreword points out that electrification of railroads is conservation, not only of material things, but also of human energy. This is followed by an abstract of a letter on Standards for Railroad Electrification addressed by George Gibbs to the Electrification of Railways Advisory Committee in England. This letter indicates that power should be developed at 25 cycles and the use of both alternating and direct current on the trolley continued. Such existing electrifications as the Hoosac Tunnel, the Norfolk & Western Railway, the Pennsylvania Railroad and the Chicago, Milwaukee & St. Paul Railway are cited as examples.

The last illustration in the book shows graphically the growth of steam railroad mileage electrified and electric locomotive tonnage in heavy traction service in the United States and Canada from 1905 to date.

Railway Electrical Engineer

Volume 13 MAY, 1922 No. 5

Boost Your Department

A few railroads in this country have a well knit electrical organization. In other cases the electrical department is well organized, but is divided into groups subject to the jurisdiction of various department heads; in some cases there is really no department at all. It is not difficult to see how this condition has come to pass. In the early days of railroading all roads used steam entirely for motive power and for driving shop machinery; the railroad organization was figuratively built up around the steam engine. As electrical equipment was developed it was adopted and used by the railroads until now they purchase approximately $40,000,000 worth of electrical equipment annually. A number of roads now use electric power for hauling trains, every shop of any size has its electric power plant, practically all shops and the great majority of trains are electric lighted, electric welding has become an important factor and any shop machine that is not driven by an electric motor is looked upon as something obsolete.

The electrical department in many cases has grown very much as it started. It has acquired size but is so diffused among the various other departments that it lacks entity. This, as has been stated, is a logical result and should cast no reflection upon anyone. Credit, however, should be reflected upon everyone who can improve the situation. Any man who can show the need for a more closely knit electrical organization and who can indicate a method for obtaining the desired result will do something which should benefit both himself and his railroad. He himself will benefit by improving the position of the electrical department and if the department operates as a unit, much lost motion and duplication will be done away with and many resultant savings will be effected.

The Electrical Engineer

Railroad operation today is not what it used to be. In keeping with other industries the ways and means employed in getting the maximum performance out of road and equipment have gradually passed from the period where things were accomplished by the "main strength and ignorance" plan, to the period where "machine strength and intelligence" is beginning to make its importance felt. Indeed, it would be quite impossible to handle the present day volume of railroad business by the methods in vogue 15 or 20 years ago. It is not difficult to picture a still greater increase in railroad business in the next 10 years which will create greater demands for electrically operated machinery than ever before.

The electrical engineer of the steam railway stands today upon the threshold of a great opportunity. The use of electricity is extending to practically every department. In some cases the application is simple while in others it is more complicated; it may be an electric fan or it may be an electric locomotive. The scope of the electrical engineer's knowledge must be wide indeed to embrace both extremes and all that lies between.

The electrical man on the steam road is rapidly coming into greater prominence in spite of all sorts of obstacles to prevent him from reaching a position of authority. The reason is not difficult to find. It lies chiefly in the fact that the economies arising from the ever-increasing uses of electric energy have become too formidable to be denied. The electric era of railroad operation is just in its beginning and the electrical man who makes the most of his opportunities now will find himself carried upward to a position of responsibility far above any that he had considered possible.

Beware of False Economies

There is no longer any question but that the general business conditions are on the upgrade. Railroads are again buying materials in large quantities to make up for the shortages in almost every line. The transportation business has been earning a larger revenue within recent months and consequently the roads are in a better position to buy. In view of the changed conditions the careful scrutiny of expenditures which characterized the meager purchases of the past few years may be relaxed or even forgotten, although that hardly seems possible. There is apt to be a tendency to buy materials without giving the matter the consideration it deserves.

Economy may be practiced in two ways—first, by reduced expenditure, which, however, is not *always* economy, and second, by the purchase of materials of high standard whose qualities have been demonstrated over long periods. Attempts to increase economy through reduced expenditures, sometimes produce exactly the opposite effect to that desired. The purchase of well-known products of high standard may also have its disadvantages. It will be found generally that such products can be depended upon for the performance of their specific functions in a most satisfactory manner, but the degree of reliability should not completely overshadow the purchase price. There is no economy in the purchase of something for which a satisfactory substi-

tute product may be had at a very greatly reduced price. On the other hand, remember that low first cost does not always mean economy. In other words, the true value of the article with relation to its cost price should be the determining factor in its selection. This question of purchasing is of first importance to every electrical man for there is perhaps no other field in which the danger of inferior substitutes is so great.

According to all indications, train control apparatus is going to find a place on the railroads in this country.

Train Control Progress

The use of train control, as has been previously pointed out, means the use of more electrical equipment on the locomotive and may even mean the transfer of signal indications from the roadside to the locomotive.

The Chicago & Eastern Illinois has used automatic stops extensively for eight years with results that have evidently been satisfactory. The Chicago, Rock Island & Pacific has used them two years and will equip a whole division. Extensive experiments are being made on the New York Central. The Pennsylvania proposes to equip 50 miles of road, single track, to test an elaborate apparatus. The Erie is to enlarge its experimental operations on the Northern New Jersey line, and the Delaware, Lackawanna & Western is going to try train control apparatus in main line service. The Chesapeake & Ohio has begun an extensive experiment.

If train control is to be adopted, two important questions must receive consideration. The best systems of train control apparatus must be selected and a force of men capable of maintaining the equipment, after it is installed, must be developed. The car lighting men or the headlight maintainers will probably be looked to to take care of that part of the electrical apparatus on the equipment.

The selection of the best system to use is obviously a difficult problem. Locomotives in some parts of the country interchange to a considerable extent and the different roads must co-operate in deciding upon what systems they will eventually adopt. This suggests joint action. It has even been proposed that the roads place the matter in the hands of a non-partisan group, composed of engineers of undoubted ability and experience who could best determine the limitations and possibilities of the various kinds of apparatus available. Such a body of men could select a few of the best systems of train control from the many and thus eliminate much needless experimenting and give the roads a better basis from which to start.

New Books

Management of Accumulators. By Sir David Salomons. 178 pp., illustrated, 5 in. by 7 in. Bound in cloth. Published by Sir Isaac Pitman & Sons, Ltd., London and New York.

This is the ninth edition of a book which first appeared as "Electric Light Installations and the Management of Accumulators." This edition has been largely rewritten and gives a general survey of the construction, management and use of storage batteries. Particular attention is given to the technique of charging and discharging, and to failures.

Letters to the Editor

Effects of Electric Power Used for Traction

SEATTLE, Wash.

TO THE EDITOR:

In the April, 1922, issue of the *Railway Electrical Engineer* there appears on page 113 an article entitled, "Effects of Electric Power Used for Traction" which deals with the question of induction interference electrolysis as related to railroad electrification. Various references were made in this article to the electrification of the Chicago, Milwaukee & St. Paul Railway Company, and we feel it necessary, in order that there may be no misconceptions regarding the conditions actually experienced on this electrification with respect to the features discussed in the article, that the following statement be made, this as such alone and without reference to any question of the relative merits or demerits of the different systems of electrification.

The C. M. & St. P. has approximately 650 miles of main line electrification. This includes 550 miles of three-phase, sixty cycle, 100,000 volt transmission line which for the greater part of its length, is located on the railroad right-of-way, in general about 100 feet in width, opposite the pole line supporting the railway company's telegraph, telephone and secondary signal circuits. The latter are of the usual open wire construction and, of course, extend the full length of the railway, including the electrified zone. Between the telegraph, telephone and signal lines and the transmission line is the 3,000 volt direct current trolley system, on the poles supporting which are located 3,000 volt trolley feeders, a 4,400 volt single-phase, 60 cycle primary signal supply circuit, and the power indicating and limiting circuit. The latter is operated at 1,200 volts d. c. on the Rocky Mountain and Missoula divisions, and at about 3,000 volts A. C. on the Coast division, the current in both cases being very small.

The telephone and telegraph lines consist of metallic dispatcher's telephone and block circuits and the usual grounded railway telegraph circuits. The dispatcher's telephone circuit is regularly used for all train movements, the dispatcher's office on the Rocky Mountain and Missoula divisions being located at Deer Lodge, 226 miles from the eastern end of the electrification and 211 miles from the western end of the electrification. Before electrification the dispatcher's offices were located at about the middle points of the respective divisions and the length of railway controlled by one set of dispatchers was only about one-half the present length. On the Coast division the dispatcher's office is located at the extreme west end of the 209 miles of electrified line. Train orders are given over these dispatcher circuits the full length of the line. The dispatcher's circuit is transposed at intervals of about 900 feet, and telegraph and telephone wires where they enter stations are fused and provided with simple standard protectors.

Electrical operation began on the Rocky Mountain division in December, 1915. At that time the feeders extending east and west from the respective substations, instead of being tapped directly at the latter to the trolley, were tapped a mile away from the substation so as to interpose a resistance which would diminish the liability of flash-over of substation motor generator sets in case of

short-circuit on the trolley. This arrangement existed pending the final development and manufacture of the so-called high speed circuit breakers which, during the year 1917 were installed in the various substations in the negative connection to the rail. The function of these breakers is, in case of short-circuit, to very rapidly interpose a small ohmic resistance in the trolley circuit, limiting the magnitude and duration of the short-circuit current to a value which will not cause flash-over of the generators and which can readily be handled by the regular feeder breaker. Previous to the installation of these circuit breakers, flash-overs of the generators were of comparatively frequent occurrence. These resulted in very little if any damage to the generator, but, at times, produced a rather severe acoustic shock to those using the dispatcher's telephone circuit, so that a few of the telephones connected thereto were provided with a megaphone horn connected directly to the original receiver. No loud speaking telephones have ever been installed on the electrified zone on account of inductive interference as stated in the article. The installation of the high speed circuit breakers, though not primarily installed for this purpose, resulted in the elimination of this trouble.

Any effects due to short-circuits on the 100,000 volt transmission system, which are of infrequent occurrence, have, as far as acoustic disturbances are concerned, been reduced to a point where they are considered negligible, largely as the secondary result of the installation of an improved relay system for high tension line, which provides a very satisfactory selective action with respect to the rapid and positive isolation of the particular portion of line in trouble. Depending on the severity and location of the short-circuit, the fuses in the telegraph and telephone wires, as referred to above, will or will not blow, but they are found to thoroughly protect the apparatus.

The article in question also states that the noise conditions were such under normal operation as to require changes in the generator construction and the installation of resonant shunts. Under normal operation there has never been interference with the telegraph and telephone circuits of any magnitude sufficient to interfere with the operation of either the telegraph or telephone circuits. Under emergency conditions, such as those above referred to, the means described have taken care of the noise conditions by doing away with the acoustic shock and the undesired operation of the protective apparatus. No changes have ever been made in the generator construction, nor have such changes been considered or contemplated.

With respect to the installation of resonant shunts referred to in the article, three such shunts were installed in the substations on the Rocky Mountain and Missoula divisions at the instance of one of the telephone and telegraph companies, who found by tests the existence in some of their circuits of a harmonic of frequency corresponding to the tooth frequency of certain of the railway company's motor generator sets supplying the trolley system. The shunts were found to practically eliminate this harmonic from the trolley circuit, and though those in charge of the railway telegraph and telephone circuits felt that the effect of the shunts in the operation of their own circuits was inappreciable, the railway company, in its desire to exercise such co-operation as it deemed reasonable and proper, and to take advantage where warranted of any means of possible improvement, permitted the installation of these shunts and included them in the contracts for apparatus specifications for subsequent electrification of the Coast division. The request with respect to the installation of the shunts on the Rocky Mountain and Missoula divisions applies to those three of the fourteen substations in which 1,500 kw. units were installed. In the case of certain of the 2,000 kw. sets of the other stations, the suggestion was made that the already comparatively minor effect of any harmonic due to these sets could be reduced to the very favorable average of the other sets by the simple expedient of shifting the generator couplings so as to secure the best relative position of the two respective generator armatures.

The article states that 60 cycle transmission lines, used in connection with the power supply to direct current trolley systems, give rise to inductive interference which is greater than that caused by transmission lines of 25 cycles serving the alternating current systems. Under exactly the same conditions, a 60 cycle, three-phase transmission line would, naturally, produce greater disturbance than a 25 cycle, three-phase line, but the actual facts are that inductive effects under normal operation are not such as to affect the practical operation of the telegraph and telephone circuits. In fact, when different sections of the transmission line were placed in operation, some of these sections being 100 or 200 miles in length, those listening in on the dispatcher's telephone circuit at the time were unable to tell when the current was switched on and off the line.

The writer of the article makes the statement that the conditions on the Chicago, Milwaukee & St. Paul are not comparable with those, for instance, on the New York, New Haven & Hartford electrification, but in what respect this is the case is not stated in sufficient detail to enable a definite idea of the conditions to be derived, either as to length, proximity, etc., of exposed circuits or the effect of conditions of traffic. It is not clear how the fact that fewer trains are run on the C. M. & St. P. than on the New Haven necessarily affects the question.

The simplicity of the interference problem in connection with the C. M. & St. P. electrification, both as regards the conditions to be met and their solution, is one upon which many visitors to our electrification have particularly and enthusiastically commented, both during their visits and in such subsequent reports as we have noted. In this connection it may be permissible for me to refer, as has been done before by others, to the following extract from a report prepared by the French commission which was sent to America in 1919 in order to make a study of the principal electrified systems in this country:

"A considerable advantage of the direct current system is that it does not seem to have any but the slightest interference with the telegraph and telephone lines,—in fact insignificant. We are well able to report that one may telephone very easily on the various lines of the railroad placed all along the tracks on an aerial wire without any protection.

"A multiplex printing apparatus for the telegraph service worked between Spokane and Helena with an earth return, was diverted especially for us in such a fashion as to use a wire placed on the poles of the electric railroad

for a distance of 270 kilos. This operated perfectly during eight days without even being troubled by three short-circuits made very complete intentionally between the trolley wire and the rail in the course of the telegraph wire."

With respect to electrolysis, this is recognized to be a question which in the case of the d. c. system should receive careful consideration. Its practical importance, as determined on basis of the protective measures necessary, will depend on the circumstances surrounding the individual case.

In the case of the C. M. & St. P. electrification, the cases of electrolysis which have arisen have been of comparatively minor importance and have required only simple and inexpensive means of correction. For instance, regarding the substation piping, particularly referred to in the article, it was found about one year after commencement of electrical operation, that at a few of the substations a small water pipe running parallel to the tracks between the substation building and the operators' bungalows was being attacked by electrolysis. As a result of tests, a copper leakage cable was installed and bonded to the pipe and the track rail, which construction was made standard at all stations. The small amount of pipe which had been severely attacked at three or four stations was removed and replaced by new pipe, with the result that it has been unnecessary to replace any pipe during the five years of service which has since elapsed.

R. Beeuwkes,
Electrical Engineer, Chicago, Milwaukee & St. Paul.

A Motor-Operated Coaling and Sanding Plant

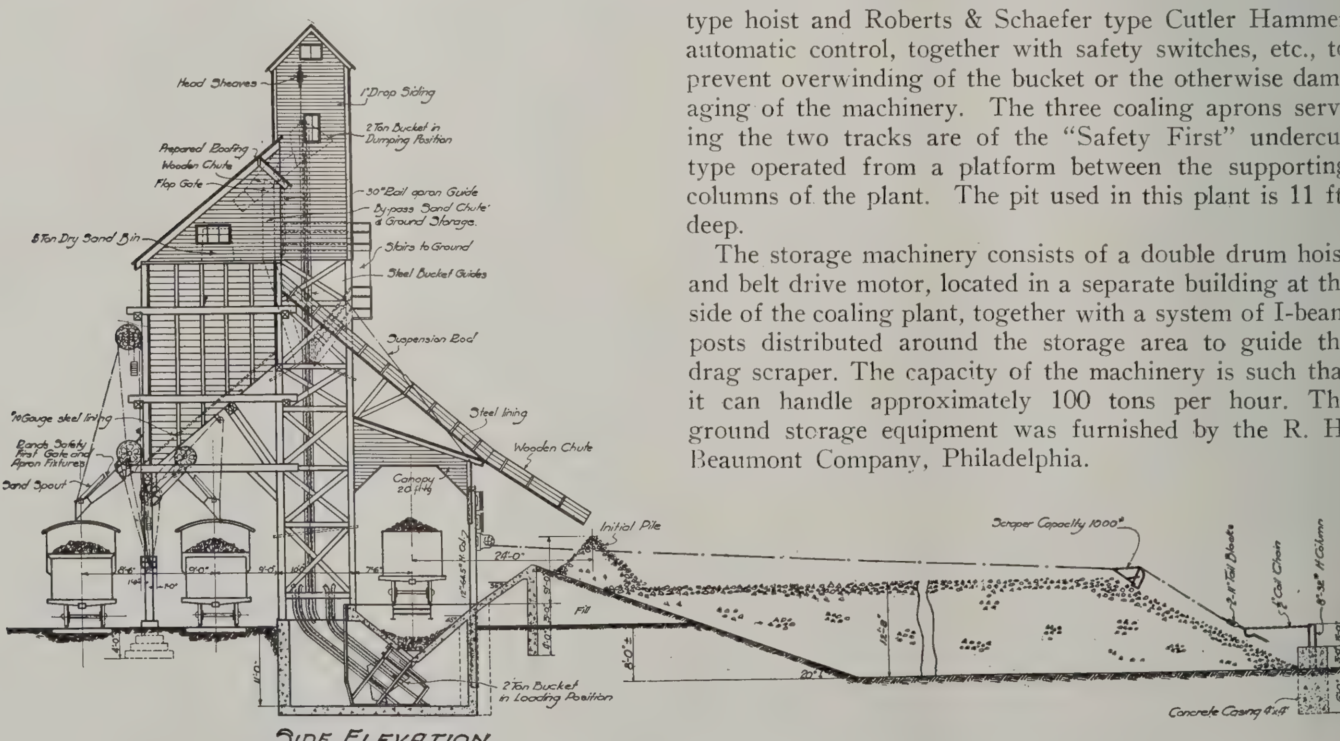
The Central Vermont has recently replaced its coaling plant at St. Albans, Vt., with facilities which present a distinctly novel treatment of the coal and sanding problem. The installation is a creation of the Roberts & Schaefer Company, Chicago, and consists essentially of a 300-ton capacity Roberts & Schaefer counterbalanced bucket, shallow pit type coaling station of frame construction and a 50-ton "RandS" gravity sand plant, together with ground storage facilities for 20,000 tons of coal.

The novel features of this installation will be apparent from an examination of the illustration and from the following description of its operation: The coal is first dumped into a receiving hopper 20 ft. in length, from which it is fed through an undercut gate into a 2-ton capacity elevating bucket, which is then hoisted in the usual manner to the point of dumping. Unlike the usual design, however, the coal in this case may either be dumped directly into the coal bin or into a by-pass chute, as shown in the drawing, the latter serving to divert the coal into a storage pit situated on the ground at one side of the plant, all coal intended for storage thenceforth being distributed by means of a 1,000-lb. capacity drag scraper over the storage area, where it may be piled to a depth of 13 ft. When it is desired to use this storage coal the operation then consists simply of dragging the coal by means of the drag scraper into the initial storage pit and over the hump into the coal hopper, from which it is elevated into the bin by the elevating buckets the same as coal from cars.

In the case of the sand plant, the wet sand is elevated in the same bucket used for coal and is spouted into a 50-ton capacity storage bin, from which it is fed by gravity into a Beamer Patent steam sand dryer. When dry the sand is then elevated by air pressure to an overhead storage bin of 5 tons capacity, from which it is fed by gravity to the engine as required.

The coaling plant has an elevating capacity of 75 tons per hour. The elevating bucket is self-opening and self-closing and all elevating machinery is automatic in its operation, the latter equipment consisting of a 22-hp. General Electric reversible motor with cast iron base drum type hoist and Roberts & Schaefer type Cutler Hammer automatic control, together with safety switches, etc., to prevent overwinding of the bucket or the otherwise damaging of the machinery. The three coaling aprons serving the two tracks are of the "Safety First" undercut type operated from a platform between the supporting columns of the plant. The pit used in this plant is 11 ft. deep.

The storage machinery consists of a double drum hoist and belt drive motor, located in a separate building at the side of the coaling plant, together with a system of I-beam posts distributed around the storage area to guide the drag scraper. The capacity of the machinery is such that it can handle approximately 100 tons per hour. The ground storage equipment was furnished by the R. H. Beaumont Company, Philadelphia.



Diagrammatic View of Central of Vermont Coaling and Sanding Plant at St. Albans, Vt., Showing Ground Storage Arrangement

Electric Freight Locomotives for Chile*

Speed on Heaviest Grade Will Be Doubled and Train Weights Will Be Increased

WORK on the 15 electric road freight locomotives for the Chilean State Railways is nearing completion. The cabs for the first eight of the road freight locomotives have been delivered by the Baldwin Locomotive Works to the Westinghouse Electric & Manufacturing Company for the installation of the equipment. There will also be seven switching locomotives.

The road locomotive has a cab of the box type, carried on two articulated trucks, each having three driving axles with direct geared motors. The estimated weight is 226,000 lb. It will operate at 3,000 volts direct current.

This locomotive has a rating of 1,680 hp. at 3,000 volts and will be able to develop a maximum of 3,200 hp. for short periods. With natural ventilation the locomotive will deliver for one hour a tractive effort of 27,950 lb. at a speed of 22.6 miles an hour at 3,000 volts. The continuous capacity of the locomotive with forced ventilation is 20,880 lb. tractive effort at 24.8 miles an hour. The maximum speed is 40 miles an hour.

The general dimensions and estimated weights of the locomotive are given in table 1.

TABLE I.

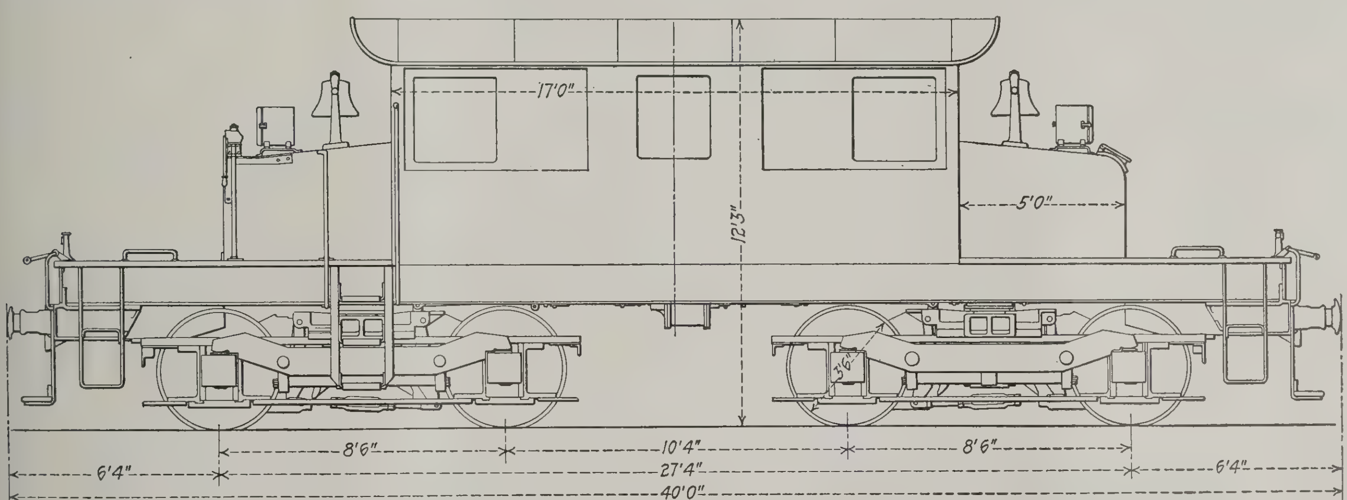
DIMENSIONS AND WEIGHTS OF ROAD FREIGHT LOCOMOTIVES

Track gage	5 ft. 6 in.
Length over buffers	49 ft. 10 in.
Length over cab	38 ft. 0 in.
Total wheelbase	37 ft. 0 in.
Rigid wheelbase	13 ft. 9 in.
Height, top of rail to cab roof	12 ft. 7 in.
Height, top of rail to clerestory	13 ft. 10 in.
Width over cab sheets	10 ft. 0 in.
Height of coupler	41 in.
Wheel diameter	42 in.
Weight of complete locomotive	226,000 lb.
Weight of mechanical parts	140,000 lb.
Weight of electrical equipment	86,000 lb.
Weight per driving axle	37,670 lb.

The road locomotives will operate over the 116-mile route between Santiago and Valparaiso and the 28-mile branch between Las Vegas and Los Andes. The heaviest grade is 225 per cent for 12 miles from Llai Llai to La Cumbre. This is known as the Tabon grade. The maximum curvature is 11 degrees. There are six tunnels in the electrified zone.

The present main line freight trains average 550 short tons. They are operated with a single steam locomotive, except on the heavy 12-mile grade southbound, and on a northbound grade of 6.8 miles. On these two sections a steam helper is now used to maintain speeds of from 10 to 14 miles an hour.

One electric locomotive will haul a trailing load of 770 short tons in either direction between Valparaiso and Santiago without assistance except on the Tabon grade. On level tangent track the speed with such a load will be 35 miles an hour. The average running speed on the Tabon grade will be approximately 24 miles an hour. The time saved by the elimination of delay to take fuel and water and by the higher running speed will shorten the time of a trip from four to five hours in each direction.



Side Elevation of Electric Switching Locomotive

These locomotives are equipped with Continental spring buffers and M. C. B. couplers, arranged to take attachments for chain couplers temporarily. The two six-wheel trucks are connected at the inner ends by a mallet hinge. The bar-type cast steel side frames are located outside of the wheels and are connected by cast steel bumpers and cross-ties. The semi-elliptic driving springs over the journal boxes on each side are connected to one another by equalizer beams. The ends of each set of three driving springs connected thus are attached to the side frames through coil springs.

The 38-foot box-type cab, including an engineman's compartment in each end and a central equipment compartment, is carried on center pins located approximately over the midpoint of each rigid wheelbase. One center pin is restrained both longitudinally and laterally and the other in the lateral direction only, which permits free longitudinal movement of the cab relative to one truck.

The locomotives are equipped with Westinghouse air brakes, which are standard for the Chilean Railways. The

*The Chilean electrification problem was outlined in the January, 1922, issue of the *Railway Electrical Engineer*, page 3, and the passenger locomotives were described in the issue of March, 1922, page 99.

air brake is interlocked with the regenerative brake so that the latter may be supplemented by service application of the train brakes, if desired, without applying the air brake to the locomotive drivers.

Current is collected by spring-raised, air lowered pantagraphs, controlled by compressed air and arranged to be mechanically locked in the lowered position. Individual switches mounted in banks establish the main circuit connections. Each switch is a complete unit in itself and may be removed without disturbing adjacent switches. Compressed air controlled by electro-magnetic valves is used to operate the switches. For certain circuits where no current is broken and for low voltages, cam switches are used. These also operate by compressed air controlled by electro-magnetic valves. The cam group comprises a number of switches mounted on a single shaft, connected through a rack and pinion to a double-acting air piston.

Each axle of the locomotive is driven by a motor, wound for 1,500 volts and insulated to operate two in series on 3,000 volts. The nominal rating of this motor on short field is 280 hp. at 15 amperes and 1,500 volts. Field control is secured by the use of two separate field windings on the main poles. The motors are geared directly to the axles with a ratio of 3.94 to 1. The gear is of the flexible type.

A motor-generator set provides low voltage power to compressors, blowers, control equipment and lights. This set has a single frame and two armatures carried by a common shaft. The 3,000-volt motor is a bi-polar double commutator machine. The continuous rating of the generator is 35 kw. at 92 volts.

A master controller is located in each engineman's compartment to provide double-end operation, the same master controller being used for both motoring and regenerative breaking. This controller provides 50 control notches in acceleration.

For regenerative braking, the main motor armatures are arranged for the same combinations as when motoring and the motor fields are separately excited by the motor-generator set. The range of speed in regenerative braking will be from 8 to 30 miles per hour.

Switching Locomotives

The switching locomotives will be the last ones built. The cab is of the steeple type and is carried on two swivel trucks. Two motors are mounted on each truck driving direct through helical gears. The estimated weight is 136,000 lb. The control is arranged for double-end operation.

The nominal rating of this locomotive is 560 hp. With 3,000 volts, and natural ventilation, the tractive effort for one hour is 19,600 lb. at a speed of 10.6 miles per hour and the continuous capacity is 11,400 lb. at 12.7 miles per hour. With 25 per cent nominal adhesion the starting tractive effort is 34,000 lb. The maximum speed is 35 miles an hour. For short periods the equipment is capable of developing 1,000 hp. In view of an expected increase in traffic these locomotives have been designed to handle trains of 1,200 short tons in yards with level tracks.

Table No. 2. gives the general dimensions and estimated weights of the locomotive.

TABLE II.

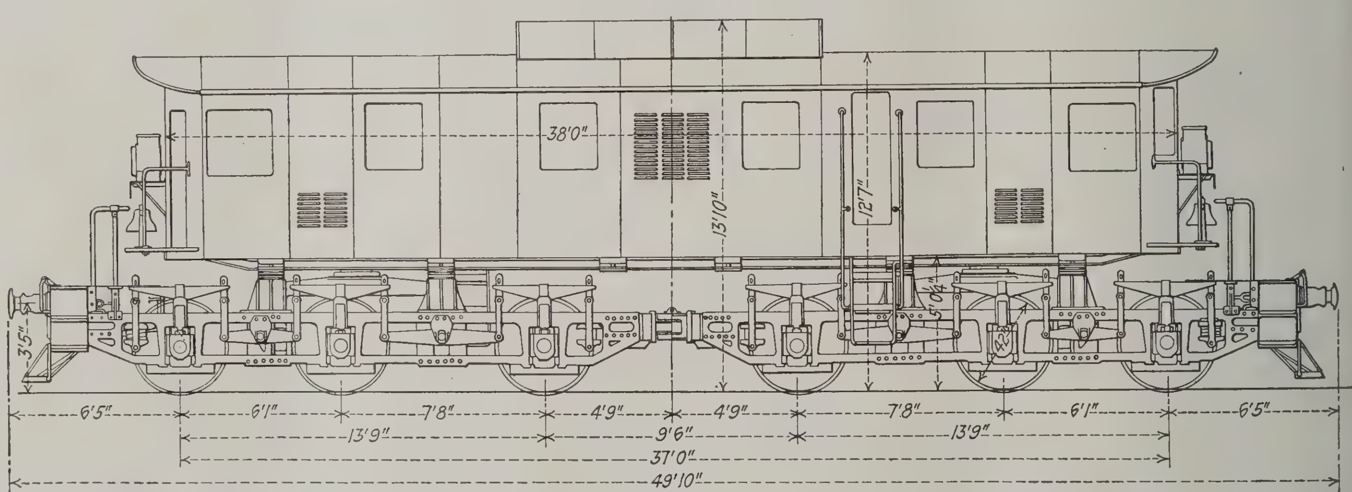
DIMENSIONS AND WEIGHTS OF SWITCHING LOCOMOTIVES

Track gage	5 ft. 6 in.
Length over buffers	40 ft. 0 in.
Length over central cab	17 ft. 0 in.
Length over hoods	27 ft. 0 in.
Total wheelbase	27 ft. 4 in.
Rigid wheelbase	8 ft. 6 in.
Height, top of rail to cab roof	12 ft. 3 in.
Width over cab sheets	10 ft. 0 in.
Height of coupler	$36\frac{7}{16}$ in.
Wheel diameter	42 in.
Weight of complete locomotive	136,000 lb.
Weight of mechanical parts	86,000 lb.
Weight of electrical equipment	50,000 lb.
Weight per driving axle	34,000 lb.

The trucks are of the rigid bolster equalized type with rolled steel frames located outside of the wheels. A center pin is located at approximately mid-length of each rigid wheelbase. Then central cab has an engineman's stand in each end and control apparatus centrally located and suitably protected. Buffers, couplers and air brake equipment are duplicates of those on the road locomotive. The control equipment also comprises apparatus similar to that already described for the road locomotives and the pantagraph is of the same type.

The four motors are of the series type wound for 1,500 volts and insulated for operation two in series at 3,000 volts. Each motor has a one-hour rating of 140 hp. at 75 amperes and 1,500 volts.

The motor-generator set, to supply power for the compressor motor, lights and control circuits, has a two-part frame, each part containing two bearings in which runs a common shaft carrying two armatures, one a 1,500-volt



Side Elevation of Road Freight Locomotive

motor (insulated for 3,000 volts) and the other a low voltage generator. With 3,000 volts applied to the motor, the generator will deliver 22.5 kilowatts at 92 volts.

The main control resistance, connected ahead of all motors, is designed with ample capacity for frequent, heavy accellerations and for a reasonable amount of emergency operation with one pair of motors cut out. The number of accelerating steps assures moderate changes in tractive effort in starting, which in turn tends to minimum wear and tear on the locomotive and rolling stock.

Shadle Automatic Train Signal-Stop

The Shadle automatic train signal and stop is of the intermittent ramp contact type incorporating cab signals and speed control. This system has been developed during the past five years on the Cincinnati, Indianapolis & Western by C. F. Shadle, signal and efficiency engineer of that road. This apparatus was inspected by the Automatic Train Control Committee of the Railroad Administration on July 11, 1919. On this test three ramps were installed and one engine was equipped. Speed control features were included and were controlled by a specially wound generator driven from an axle, so designed to close the circuit to the brake valve at a certain speed, permitting a de-energized ramp to be passed, if the circuit controllers were operated by the engineman and fireman at the same time.

The circuits are so developed that the system will work in conjunction with existing automatic signal systems, or, if introduced on roads not so equipped, it will operate without the necessity of such an installation as the engineman gets the indication from signal lights located in the cab. These lights will indicate to him the action necessary for him to take. If such action is not taken the brakes are set and the train is automatically brought to a standstill.

Type of Apparatus

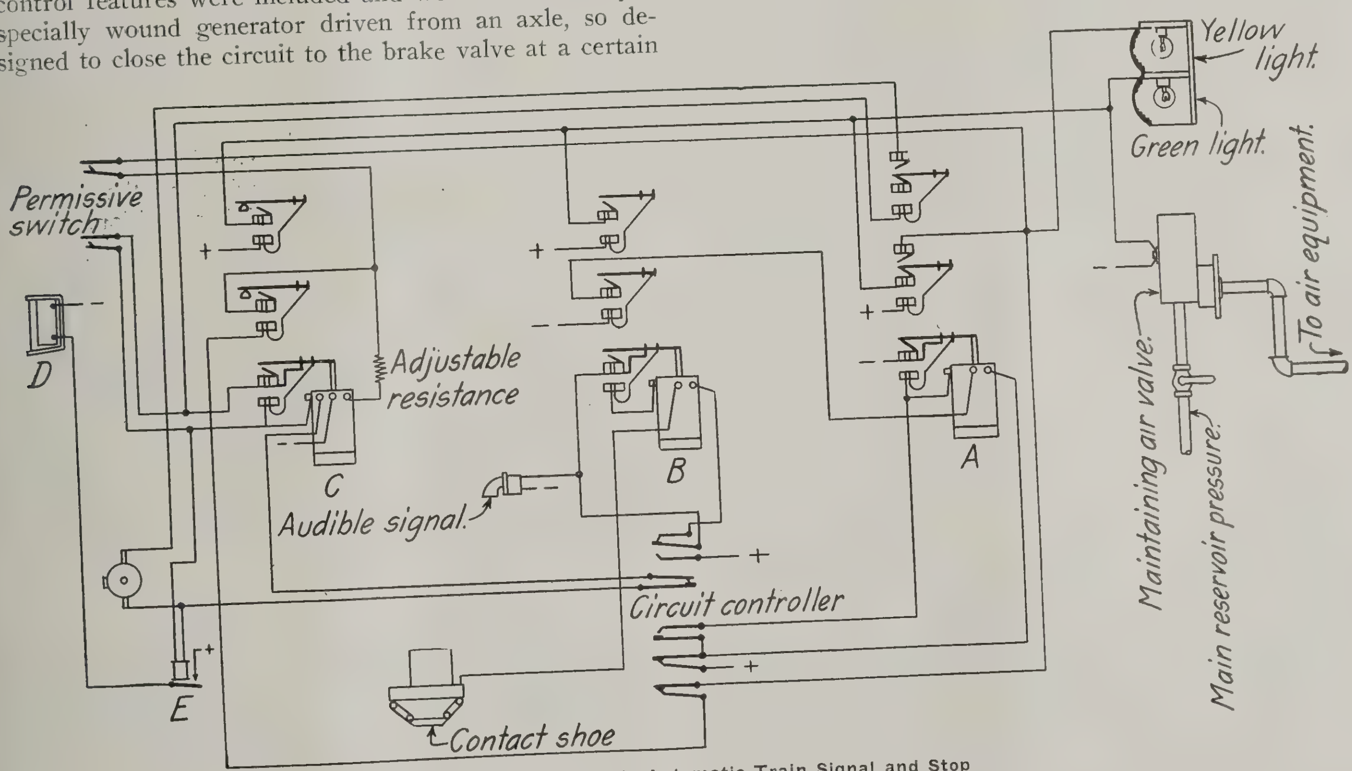
All of the electrical devices employed in this system are standard parts, as manufactured by the Union Switch & Signal Company for electro-pneumatic signal and interlocking purpose, the system being so designed that it is not necessary to manufacture or introduce any new devices unknown in the signal field.

Five miles of the main line on the Cincinnati, Indianapolis & Western has been equipped with the necessary local contacts, consisting of 40 ft. ramp rails and a passenger engine has been in regular daily service between Indianapolis, Ind., and Cincinnati, Ohio, running over this portion of the line, which is also equipped with automatic signals.

In order that the engine equipment may not fail to pick up the electrical impulse required to operate it when running at high speed in passing over a 40-ft. ramp rail, a retarding device, or "stick" circuit, is so arranged that the time of contact between the traveling vehicle and the ramp rail is not the important item.

The Circuit Arrangement

Referring to the general arrangement of the circuit and the mechanism as applied to an engine it will be noted

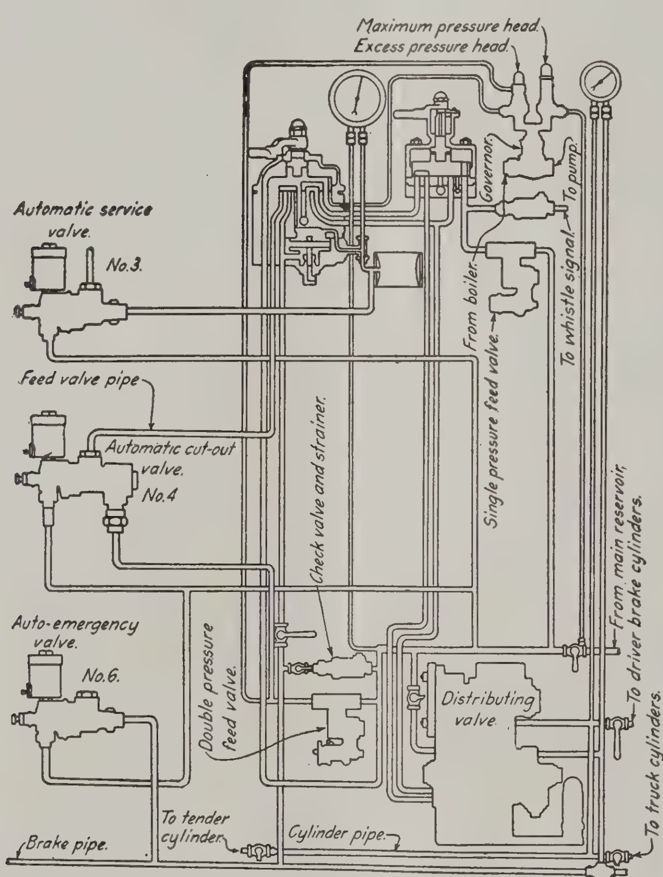


Circuits of the Shadle Automatic Train Signal and Stop

that the electric solenoid movements *A, B* and *C*, also the engineman's control switch *b*, consists of standard Union Switch & Signal Company's magnets as used in electro-pneumatic interlocking. The electro-pneumatic relays *1* and *2* are shown on the circuit plan, are interlocking dwarf signal movements, with no changes in the mechanism except the addition of one or more circuit breaker contacts to the movement.

The positive wire from a 12-volt local battery at a signal or a track location is carried through the points of a track relay to the 40-ft. ramp rail, the negative side of the battery being connected to the track rail. A 12-volt

Edison storage battery of 60 ampere hours' capacity is carried on the engine, the negative side of the battery being tapped to the frame. The contact shoe is mounted at the front end of the engine just back of the pilot and the wire from the positive side of the storage battery on the engine is looped through the wearing plate on the shoe so that if it should be torn off or otherwise damaged this wire would be broken. When the engine leaves the roundhouse the air brake equipment on the locomotive is tested. At the same time the signal device must be put into service in order to open the feed valve pipe before the brakes can be used. The cab signal would, therefore, show a yellow light. In order for the engineman to have control it is then necessary for him to push the engineman's control switch. After these contacts are closed both the green and yellow lights will appear, indicating to the engineman that he has control, thereby preventing an automatic application of the air. This condition will continue until the train enters the first clear block; then the apparatus will automatically release the engineman's valve, and the yellow light will disappear,



Air Control Devices and Pipe Connections

while the green light will remain, thus indicating that the block ahead is clear.

With reference to the engineman's control switch it is to be noted that this switch is to be operated by the engineman on the appearance of a yellow signal light, which indicates that he has entered a caution block or an occupied block. This switch, however, does not remain in the holding position through consecutive caution or red blocks, but releases automatically on entering a second block indicating caution or stop, thus insuring that the engineman does not forget that he has assumed control and also compelling him to operate the switch manually in order to prevent an automatic application of the brakes. The service brake valve *3*, as shown on the plan, operates a hand-set release. This hand release requires that the engineman get on the ground to reset it after the train has been brought to a full stop, thereby closing valve *3* before the brakes can be released. However, it is not necessary to use a hand release if this feature is found undesirable, as the engineman can release the brakes immediately by operating the engineman's control switch and proceed without stopping, if the brakes go to a service application.

The diagram illustrates the method of connecting the air controlling device with the air brake system on the locomotive. The service application is relied upon entirely to stop the train with the intermittent set-up timer on both brake reduction and time between reductions. With this device it is possible to secure automatically a given amount of service brake reduction in pounds and a given period of time between successive reductions in minutes or seconds as may be desired according to the tonnage of the train and the stopping distance required. To make the locomotive signal effective the local contacts should be placed from 800 ft. to 1,000 ft. in advance of the block in order to give the engineman advance information, so that he may have sufficient time to assume control and prevent an automatic application of the brakes and at the same time acknowledge the signal indication.

The automatic control apparatus must be put in service at the same time the brake on the engine is tested at the terminal by closing the control switch on the engine or the brakes will remain in the holding position. At the first clear block the engine signal will change to clear, but if the fixed signal is at caution or stop, the signal in the cab will change to yellow and release the device ready to apply the brakes automatically in a service application, unless the engineman on the appearance of the yellow signal assumes control by again replacing the holding switch. This condition repeats at each red or caution block, when the system is set up for the service application. The apparatus is so constructed as to be operative equally well when the engine is running either forward or backward.

Photo from Underwood & Underwood, N. Y.

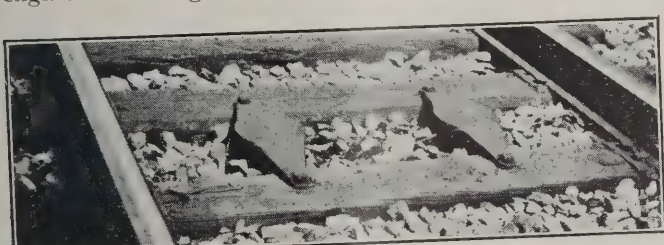
The Metlac Bridge on the Line from Mexico City to Vera Cruz

The Train Now Being Used on the New York Central to Test the Train Control System

The Sprague System of Auxiliary Train Control

Apparatus Is Now Undergoing a Series of Daily Tests on a Section of New York Central Track

THE Sprague System of auxiliary train control, in the words of Frank J. Sprague, who is responsible for its development, is not an automaton in the place of an engineman, but an auxiliary system of train control which, while fully protecting the train and re-inforcing the engineer's intelligence, leaves him practically undisturbed in the handling of his train so long as he performs his duty.



The Two Pole Pieces of a Brake Application Magnet. The Permanent Magnet Which Connects Them is Underneath the Ballast

In developing this apparatus, the designers have been guided by a set of specifications which they themselves have laid down. They maintain that a system should:

"Be applicable to any single or multipe track railroad, with or without automatic visual signal equipment; and in the case of the former regardless of whether alternating current or direct current danger or normal clear signals are used, with or without interlocks and overlaps.

"Be suitable for any road regardless of the kind of power used, whether steam or electric; and in the latter case uninfluenced by the kind of current or type and location of conductors.

"Not encroach upon the clearance lines of rolling stock or track equipment, or be limited by extraneous equipment along the right-of-way; or interfere or be interfered with by snow plows or dragging equipment.

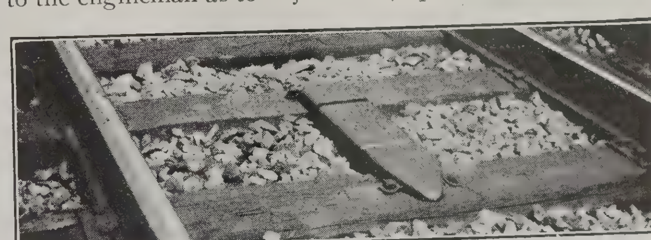
"Be unaffected by climatic extremes, proof against interruption by water, snow or sleet, and subject to a minimum of depreciation.

"Provide distinctive cab signals and full block protection, as reliably as any possible wayside signal.

"Provide speed limitations, regardless of signals, or tangents and curves where required, and insure slackening to safe running speeds on entering a caution block.

The engine equipment should be:

"Readily applied to all types of road engines, passenger and freight, and once installed be a matter of no concern to the engineman as to adjustment, upkeep or replacement.



A Reset Magnet

"Unaffected by shock, jar and vibration, and proof against roadway dust and changes in atmospheric humidity.

"Readily replaceable, at least as easily as the standard parts of the regular brake equipment.

"Of such character that a locomotive can be used interchangeably on all kinds of train service, and with any kind of braking which may be required.

"Subject to speed-control, that is, to a proper co-ordination of the elements of train speed and braking power of equipment.

"Engine and track equipment should be as nearly as possible foolproof, and demand the minimum of upkeep

and attention, both as to time occupied and special knowledge required; and all necessity for adjustments, or even possibility of such by the engineman, should be eliminated.

"Finally, the system should be for the engineer a friendly mentor and guide, aiding, not unnecessarily opposing him, a thoroughly reliable but unobtrusive partner in the operation of his engine, which while at all times interposing an effective shield between him and disaster, wlil leave, within all proper limits, the handling of the train subject to his judgment."

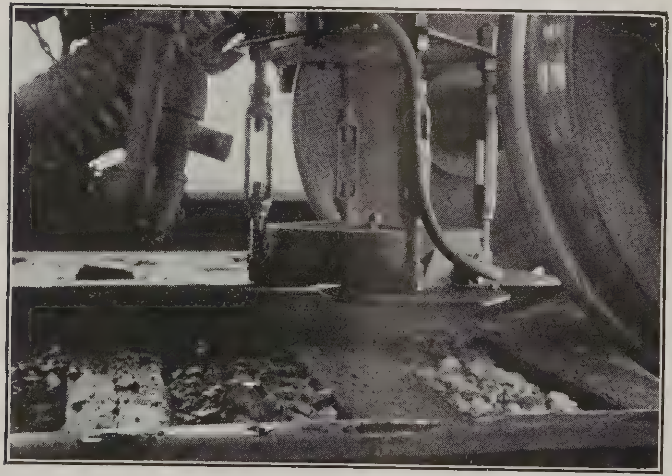
Track Equipment

All apparatus on the track, as well as on the locomotive, is operated on the normal danger plan. Assuming a train in the block section approaching the block to be protected (which may or may not be occupied by a preceding train) it encounters two normal-danger, brake-application magnets, one near the entrance end and one at the critical point in the block, and there is a differential reset magnet near the exit end.

The brake-application magnets are of the permanent magnet type with neutralizing coils wound on the two ends or pole pieces, while the reset is simply an electro magnet. All of the magnets are controlled by the track circuit relay of the section in advance, the brake applying magnets being normally alive and the reset normally dead.

When a train enters this approach block, and the block ahead is clear, the application magnets are made inactive by the neutralizing coils, thus permitting the magnetically responsive receiver on the locomotive to pass through the space over the magnet poles without being affected. If the advance block is not clear then the application magnets will remain normal, or active, and the magnet receiver on the locomotive is subject to their influence. The reset magnet then is inert.

The track magnets are enclosed for protection in sealed



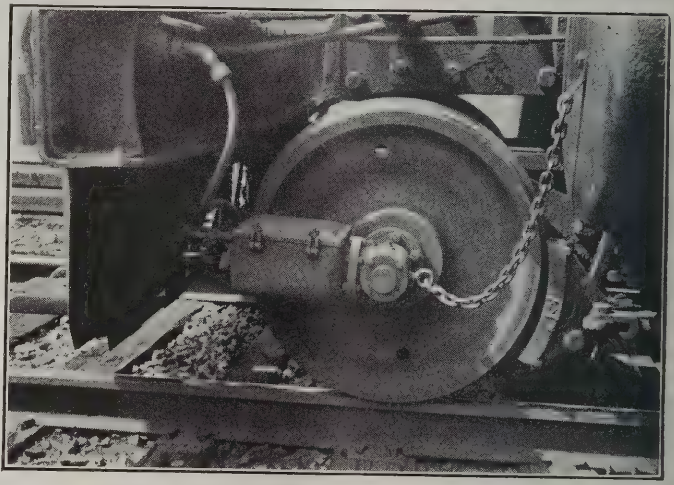
The Receiver Under the Forward End of the Tender

manganese steel casings which are supported in the ballast, between adjacent ties, by extension arms resting upon and secured to the ties. The application and reset magnets are placed at right angles to each other in the center of the track, the application magnets being parallel to the ties, and the reset magnets parallel to the rails. This insures proper registration and operation of the apparatus on the locomotive regardless of the direction of motion or heading of the locomotive. The faces of the magnet poles are between four and five inches lower than the tops of the running rails.

Locomotive Equipment

A double receiver is hung under the forward end of the tender on adjustable supports. This receiver is composed of two pairs of flat iron collector plates attached to the bottom of a non-magnetic box. These plates are from three to four inches higher than the tops of the running rails, thus making the distance from the track magnet to the receiver about seven or eight inches.

The magnetic flux from the track magnet is carried,



The Speed Control Mechanism

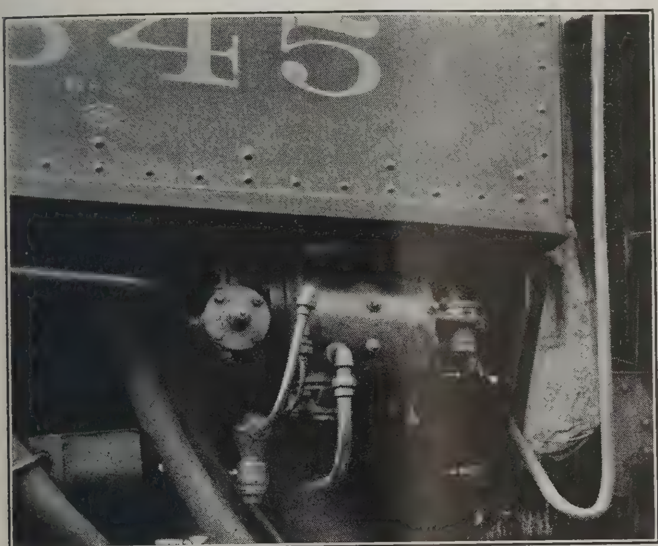
through movable iron cores within the receiver box, to a floating receiver in which this flux is concentrated on one or the other of two moving armatures of small mass. The application magnets affect one armature while the reset magnets affect the other. The tops of the pole pieces are eight inches in diameter, and when a locomotive is running at a high speed the receiver will pass over the track magnet in less than 1/100th of a second. During this time the small armature in the receiver breaks contact momentarily.

Relays.—The momentary breaking of contact by the armature in the receiver is translated into action by relays mounted in a box located on the running board. There are three relays, operating self-centering pressure contacts in definite sequence. These relays will respond to impulses as short as 1/1000th of a second. They are sealed and cushioned, and it is claimed they are unaffected by vibration.

Valve Assembly.—The impulses picked up by the receiver and passed on by the relays, result in influencing the action of two pilot control valves located underneath the cab on the fireman's side. The function of these control valves is to establish an opening to atmosphere from one or another of the piston chambers which control the movement of a ported slide valve. The operation of this valve will, as may be determined by a selector valve, effect any required combination of measured and limited light and heavy service and emergency brake applications under speed control, with or without enforced stop if the automatic brakes come on, or with the privilege of proceeding under limited speed until released. The operation of this valve assembly may cover any one of a number of different possibilities, depending upon the conditions of train

make-up and of operation met in practice. Under usual conditions of operation, caution and stop signals will cause two brake applications, called primary and secondary. The character of these two applications is governed by the selector valve. Primary and secondary braking may be used in any combination, for example as follows: 10-lb. and 25-lb. reduction; 25-lb. reduction and emergency application; nothing and 25 lb., and so on. The valve assembly is applicable to any kind of standard brake equipment.

Speed Control Mechanism.—The speed control mechanism is carried on the front end of the locomotive, one end



The Valve Assembly

of it being supported on an extension of the forward truck axle. The other end has a spring-suspended nose support. The drive is by enclosed bevel gearing running in oil, while the governor assembly is carried in a dry chamber in which there is a centrifugal governor, a small air cylinder together with fixed and movable end-contact steel brushes.

A single flexible air hose and a flexible electric cable, terminating in a standard coupling, are attached to the free end of the speed control mechanism. The air hose is connected to the engine brake system. The whole constitutes a combination of a speed-responsive device (not an odometer) and a brake-responsive device, by means of which the necessary co-ordination may be automatically secured to prevent unnecessary operation of automatic braking.

The remainder of the equipment on the locomotive consists of a small storage battery and the headlight generator for supplying the storage battery; a manually and power-operated engineer's valve interchangeable with the standard valve; and two pairs of signal lamps, one on each side of the cab. The engineer's valve is operated by air-oil pressure when a track impulse is received. This pressure is used to move the handle of the valve to lap position, the actual braking, other than manual, being accomplished by the automatic valves under the left side of the cab. The green lights show when the equipment is in running order and the block ahead is clear, and the yellow ones when the relation between speed and manual braking is such that it is safe for the train to proceed under control.

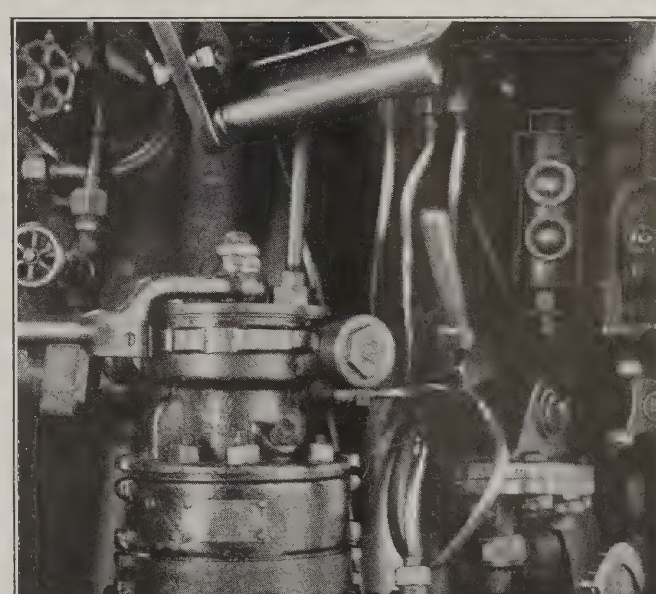
Operation

On entrance to every block the cab signals indicate whether or not the next block in advance is occupied. If the signal at the entrance of the advance block is at caution, then, on passing over a live distant magnet, the green light disappears, an audible warning is given and a service brake application is initiated, this being light or heavy, depending upon how the selector valve is set. The yellow proceed light appears if braking is sufficient to forestall secondary braking at the home magnet.

The engineer's brake handle will be moved to lap position, but it can then, with effort, be pushed back to the release position, against the brake-head operating pressure on the motor pistons, which pressure will then be promptly released if the train is not running above the predetermined caution entrance speed. If the engineer is attending to his duty he may, therefore, forestall actual braking of the train or he may promptly release his brakes in response to a change in roadside signal indications. The automatic service brake application may be augmented or diminished manually at will.

If the selector valve has been set for no primary brake application, as may be required in the movement of slow freights, then only an alarm will be given if the speed is under control.

If the engineer, while approaching the home magnet, makes a service brake application, the yellow light will appear in the cab whenever there is sufficient braking to



The Special Head for the Engineman's Brake Valve and One Pair of Signal Lamps

insure reducing the speed to "control" speed in a suitable distance after passing a live home magnet without automatic secondary braking.

If the danger condition persists when passing the home magnet a second service braking will be initiated, which may likewise be released by the engineer, but conditions are established for an immediate or subsequent secondary brake application, according to the speed and braking conditions which then or thereafter obtain within the block.

If when getting the second impulse at a live home magnet the locomotive is running without braking and below

the determined control speed, say 15 or 20 miles an hour, as indicated by the yellow lamp, and so continues until reaching the reset magnet, there will be no secondary brake application, but if the speed is increased and goes above the control speed before passing an active reset magnet, the brakes will be applied.

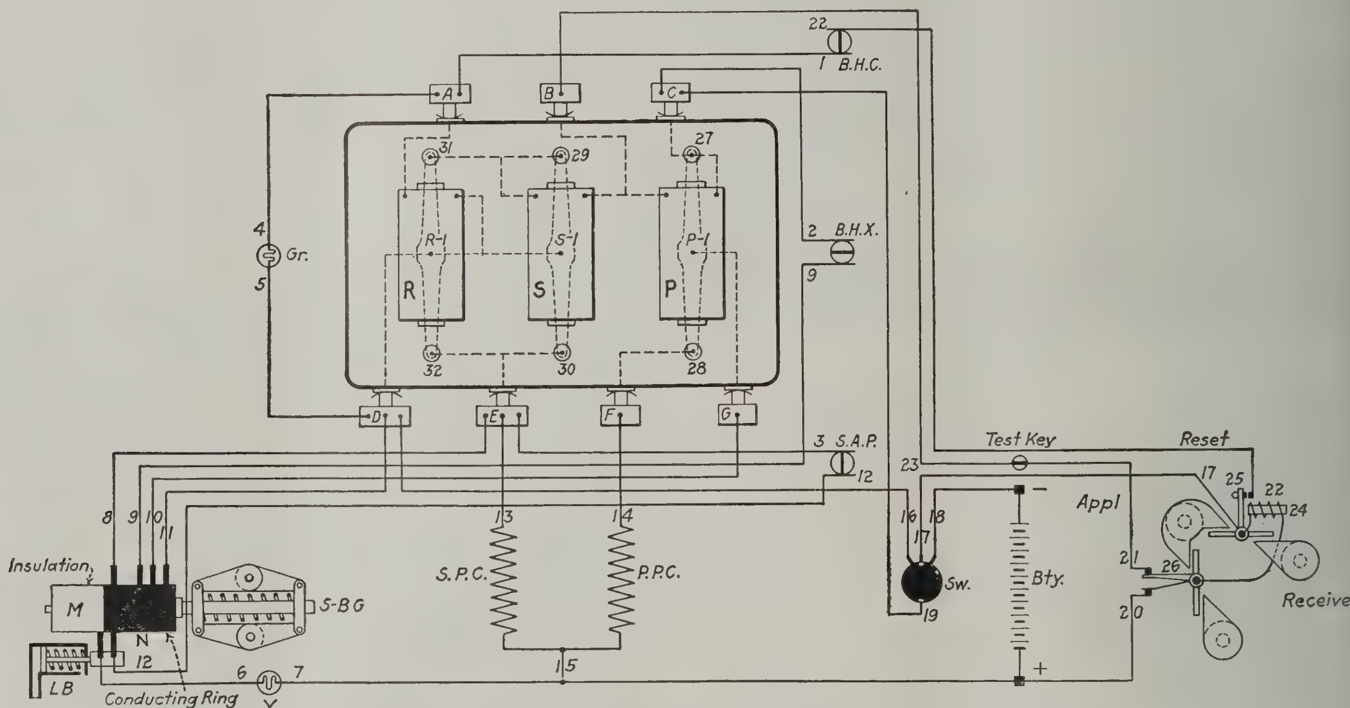
If the engine when passing a live home magnet is running below the predetermined speed limit, say 45 or 50 miles an hour, and the train as a whole is being properly braked under a manual or automatic service application, the secondary braking will not take place; but if the brakes are released before reaching the control speed, then a heavy service or emergency braking will occur, depending upon the setting of the selector valve. The secondary brake cannot be released, however, until it has completed its function, no matter how short the initial impulse or whatever the engineer attempts to do with his brake handle.

When the speed has been reduced to "control," the mum speed brake impulse and not having been pulled down to a suitable speed, should enter a caution block, then it will get a secondary braking at the first application magnet.

If under any conditions the secondary brake has come on, the predetermined set of the selector valve will determine whether the train can proceed under control on the engineer's initiative alone, or whether the train must first be brought to a stop and require the co-operation of the engineer and fireman outside of the cab to release the brakes.

When passing over a live reset magnet the engine relays will be restored to normal position, ready for response to the next live application magnet, no matter whether there have been one or two application impulses received, and if none has been received the reset impulse will have no effect on the apparatus. The reset only restores the control relays to normal; it has no effect on the brakes.

If, however, when passing the reset magnet it is not



A Complete Diagram of the Electrical Circuits and Connections on the Locomotive

Bty ....Battery.
SW ....Main switch.
P, S and R .....Primary, secondary and reset relays.
PPC and SPC ...Primary and secondary pilot valve coils.
MN ....Speed-brake controller.
26-25 ....Application and reset armatures.
Gr and Y ....Green and yellow lights.
BHC and SAP ..Contacts operated by pressure in brake head cylinder and straight air pipe.
BHX ....Contact operated by absence of pressure in brake head exhaust.

brakes may be released, but if the speed is later increased above the low limit before passing an active reset magnet, the secondary or emergency braking will again take place.

If the engine when passing a live home magnet is running above a predetermined high speed limit then there will be an uncontrolled secondary braking which cannot be released until its function has been completed.

When running above a predetermined allowed maximum speed on a clear track, a service brake will come on, regardless of the roadside signal indication, and the train speed must be pulled down to a safe caution block entrance speed to have the pressure on the engineer's brake handle released before passing a reset magnet.

If under these conditions a train, having had a maxi- energized by the clearing of the home signal, the reset will not act and the allowed speed will be held down to the control limit, but the train may proceed into and through the next block under control.

If the conductor unlocks a control switch he can temporarily give to the engineer and fireman the privilege of joint action to establish an early reset, if and only when the proceed cab light is in evidence.

In interlocked or other special territory an additional reset magnet may be installed to permit earlier acceleration in case the signals go to clear, and provision can also be made, subject to the positive control of the train conductor, so that simultaneous co-ordinated action by an engineer and his fireman can reset the relays to normal.

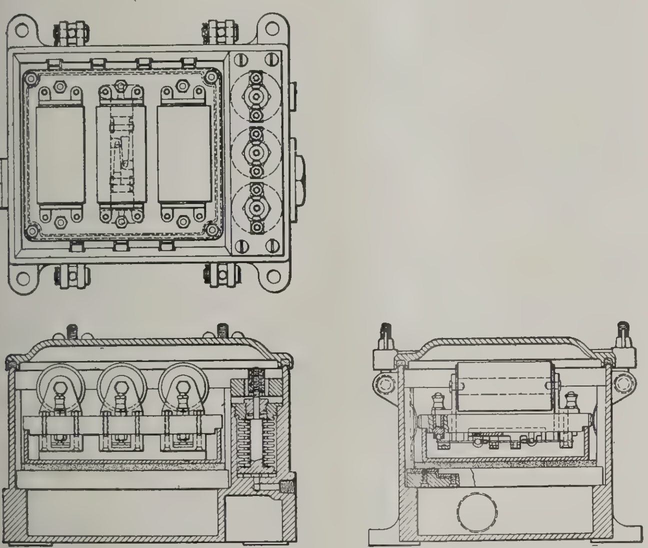
The response to the service brake impulses, and to the secondary brake impulses when exceeding the speed limits, as well as to the resets, is exceedingly rapid, and both brake controls are operated on closed circuits.

Sections under speed control, as for example, dangerous curves or bridge or crossing approaches, may be treated as permanent signal blocks, each being provided with one or more permanent application magnets to initiate service braking at the proper point if the speed is excessive, or later if it is augmented, and a permanent reset magnet after the curve is passed. Portable magnets may also be used for wayside emergency conditions control.

The brakes once applied, the actuating pressure on the brake valve handle persists until the speed is reduced to a predetermined limit, which is individual to each class of locomotive.

All of the electrical connections in the apparatus are shown in the diagram.

First Impulse.—When application contact 21 is momentarily opened, relay P and S are de-energized and drop their armatures P-1 and S-1. The dropping of P-1 opens



Plan and Sections of the Relays and Relay Case

stick contact 27 and the circuit of the primary pilot valve coil PPC, with resultant primary brake application. The dropping of armature S-1, while opening the stick contact 29, does not then break circuit of relay S because the additional stick contact 31, controlled by armature R-1 of reset R, is still closed. The re-closing of contact 21 immediately energizes relay S and picks up armature S-1.

The application of pressure to the engineer's brake head puts pressure on the BHC switch, opens the reset circuit, breaks green lamp Gr, de-energizes reset relay R, drops armature R-1 and breaks contacts 31 and 32, relay S remaining energized through stick contact 29. There is, therefore, a condition established in which, instead of P, S and R being all active, as in normal running, P and R are opened and S is still alive.

The movement of the brake head pistons opens BHX to atmosphere and closes circuit from relay P through speed brush 9 and cylinder contact N to negative line through brush 11 and switch Sw. This response is permissible only when cylinder contact N, which is normally shifted to the left with increase of speed, is moved sufficiently far to the right to permit brush 9 to make contact with cylinder N. Under these conditions relay P picks up and there is now established these conditions: P and S active and R dead, BHC being meanwhile closed on release of brake head pressure, relay contact 22, however, being left open.

Second Impulse.—On second impulse from the track the contact 21 is again momentarily opened and P and S again de-energized, but this time (contact 31 at reset relay R being now open) the dropping of armature S-1 opens the stick contact 29 of relay S, and this relay therefore remains dead, although contact 21 has closed; relay P can be restored as before. The condition of the relays now is: P alive and S and R dead, and two of the four circuits, 8-3-30 and 32, in parallel and connected through 13 to the secondary pilot valve SPC, are opened, leaving the control of SPC through brush 8, or movable brush 12 and the switch operated by SAP.

Brush 12 and brush 6, connected to proceed light Y, are moved to the left by pressure in the locomotive brake system in the same direction as NM is moved by the centrifugal governor. If SAP is opened then the final control is on brush 8, but if SAP is closed the control is shifted to brush 12, that is, to a co-ordinated position depending upon speed and braking. Contact 6 breaks before contact 12, and hence the yellow light Y becomes a warning and proceed light.

Reset Impulse.—On receiving a reset impulse, contact 22 is closed by armature 25 and locked closed by holding coil 24, which is a part of the receiver. Relay R is, therefore, made active; contacts 31 and 32 are closed by R-1 and green lamp Gr is lighted, while S is likewise re-energized and through contact 31 all circuits, relays and pilot valve coils are restored to normal condition. If only one application impulse has been received, the reset contact on the receiver simply restores R and Gr to an active condition, S already being energized.

Tests are now being carried on for seven hours a day, six days a week, on a section of the New York Central, between Ossining and Tarrytown, covering six signal indications on eastbound track No. 2. This is about 30 miles from New York. All other trains are temporarily excluded from this section and several hundred recording operations, under varying conditions, are made each week. Electric locomotives and multiple unit trains which take direct current from a third rail, with a traffic rail return, are operated on this section of the road. The automatic block signal system is normal clear and the rail circuits are alternating current. The normal danger track magnets are supplied from storage batteries located along the right-of-way maintained by a trickling charge from the alternating current power lines.

This train control system was developed by the Sprague Safety Control & Signal Corporation, 421 Canal street, N. Y.

Permission has been granted by the Chilean Government for the construction and operation of a new railway line between the port of Lebu and Los Sauces, connecting at the latter point with the State railways and passing through Canete, as reported by Chargé d'Affaires John F. Martin, at Santiago. The grant provides that construction shall begin within one year from September 2, 1921, and that the road shall be completed and ready for operation within four years from that date.

The American Train Control System

Locomotive Wiring Provides for Bell Warning Signal as Well as Visible Light Indications in the Cab

THE apparatus of the American Train Control Company was first developed on the Maryland & Pennsylvania railroad and was brought before the Interstate Commerce Commission in 1907. It was not fully developed, however, until the apparatus was installed on the Chesapeake & Ohio.

The installation between Charlottesville, Va., and Gordonville on the C. & O. was inspected by the Automatic Train Control Committee under the Railroad Administration on April 15 and 16, 1919, at which time 21 miles were in service and 32 engines were equipped. This installation has now been in service for three years.

A Light Signal Location

The system is of the "intermittent contact" or ramp type. The ramp is fixed to the ties 27½ in. outside the gage line of the running rail. On the right hand side of the track all of the ramps are arranged to apply the brakes (when the block ahead is not clear); while on the left hand side all of the ramps are arranged to give only the cautionary indication in the cab. In connection with each three-indication signal there are two ramps, one on the left hand side corresponding to the cautionary indication of the signal, and one on the right corresponding to the stop indication of the signal.

The installation of automatic block signals of the color type light is now being extended 20 miles to Staunton, Va., and train control apparatus is being extended to cover this territory. Some 38 locomotives are now equipped with the automatic control apparatus and as soon as the extended control facilities are in service all locomotives operating over both divisions are to be equipped. With the latest improvements of the device the cab signal and application of the air control are operated by one shoe from one ramp.

The Contact Shoe

The contact shoes are of the single moving element vertical rise type. The diagram shows the interior of the contact shoe and the method of operation of the circuit breaker, contacts *X* and *Y*, and the shoe pressure mechanism. The contact piece is free to turn at will and the contact *D* is circular in form for making proper contact irrespective of the position of contact *C* and plunger *B*. The contacts *X* and *Y* are arranged one above the other, so that when the shoe passes over a ramp rail the plunger rod *B* is forced up, the contact *Y* will pass off the contact cylinder *D* on the insulating rubbing ring *W*, when the plunger rod has raised from ½ to ¾ in. Contact *X* is so arranged that it never goes off the cylinder *D* when the shoe is raised to full height, and this cylinder is in constant electrical contact with the plunger rod *B* and contact *C*. Plunger rod *B* is insulated from all other parts of the contact shoe and the frame of the engine.

The contacts *X* and *Y* are supported on an insulating block *S* securely fastened to the top housing. The bell contact shown on top of the cylindrical contact *D* is insulated from the plunger *B* and the contact *D*, and the two bell contacts are arranged to close when the shoe raises about ¼ in., thereby ringing a vibrating bell in the cab each time the contact shoe goes over a ramp rail. Certain designs provide an electric light and an air whistle in the cab eliminating the electric bell. The contact shoe is fastened at a distance of 27½ in. from the gage of rail and the contact piece rides 4½ in. above the top of running rail. These clearances were necessary because of various types of engines in use on the Chesapeake & Ohio. One added feature not shown in the diagram is the extension of the air connection into the shoe, in such a manner that providing the shoe is broken off the exhaust of air will operate the brake mechanism.

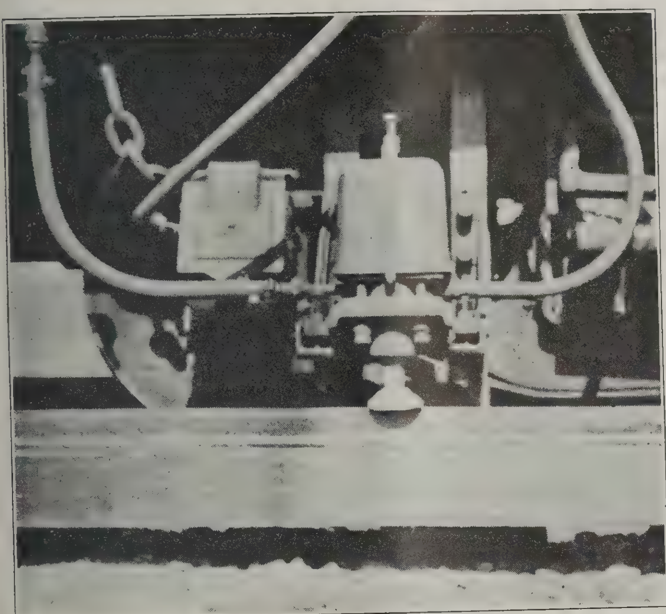
The Valves Used

The train line blanking valve is installed as a by-pass valve for the train line pressure between the engineman's brake valve and the double-heading cock. A cut-out cock is provided in this same line and its position is sealed closed, so that the train line air will have to go through the blanking valve in order to get to the train line on the train. This valve is of the differential piston type. Its function is to cut off or blank the train line pressure from the train upon receipt of an automatic stop. This prevents the engineman from releasing the brakes on the train until it has been brought to a full stop.

By referring to the diagram the operation of the magnet valve may be followed. It is seen that the armature (shown down) has a stem *S*, the upper end of which

forms a seat and a cavity to guide the pin valve *p*. When the armature is energized the stem *S* is raised, which in turn pushes the pin valve *p* off its seat, thereby allowing main reservoir air pressure to pass into chamber *n* of the magnet valve body, and chamber *l* of the train line vent valve as well as to chambers *e* and *d* of the train line blanking valve and brake control valve, respectively.

Referring to the train line vent valve, the main reservoir pressure in chamber *l* causes the diaphragm to press down valve stem *31* seating soft seat *32*, thus preventing train line air pressure, which is in the lower chamber of the vent valve, from escaping to atmosphere through the



The Contact Shoe

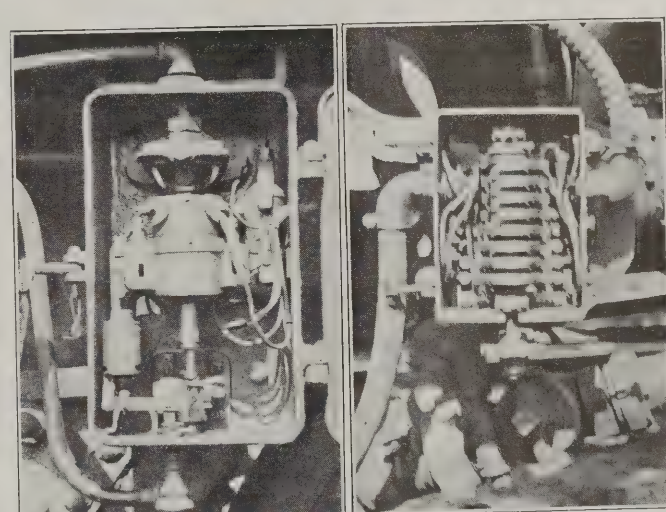
vent port *28*. The main reservoir air pressure in chamber *l* of the vent valve, chamber *n* of the magnet valve, chamber *e* of the train line blanking valve and chamber *d* of the brake control valve is held in check by means of the armature stem seating and closing the relief port for main reservoir air pressure. When the magnet drops for any reason this relief port is opened to atmosphere, thereby relieving this pressure in all the chambers mentioned above, which in turn allows the opposing pressure to work its respective valve and perform its regular functions.

If the stop shoe passes over a de-energized ramp rail, the circuit to the magnet *M* is interrupted and armature *e* drops, causing pin valve *p* to seat and cut off main reservoir pressure from the top of the diaphragm in the vent valve, and, as stated above, allows the air that was in the chamber *l* to escape to atmosphere through the relief port. Train line pressure on the bottom side of seat *32* forces that seat open, allowing train line air pressure to escape to the atmosphere through port *28*. This train line air is piped from over the top of the engineman's cut-out cock directly in the train line, so that when it becomes necessary for him to double-head he automatically cuts out the automatic stop valve. This same magnet is made to control the operation of holding the train line blanking valve and the brake control valve open by main reservoir pressure in the same manner as the vent valve.

A cut-out cock is put in the valve box to provide means for the engineman to prevent the operation of the automatic stop valve venting the train line air to atmosphere, whenever there is necessity to do so, as in case of broken pipes, failed parts or broken batter wires, etc. This escaping air must be stopped or otherwise the train cannot move.

The reset valve is placed in the other path of the train line air as shown in the diagram. This valve is a normally closed air valve and the only time it is opened is when the engineman resets the stop valve after an automatic application of the air brakes occasioned by the magnet valve dropping. It serves a triple purpose in that it resets the armature of magnet *M*, which drops away too far for it to pick up after it has once dropped; it vents train line pressure through a double port on either side of the valve when it is held up and this prevents the engineman or others from tying this valve up to prevent the magnet valve armature acting; it also serves to give the engineman and the maintainer an indication that the blanking valve on the engine is working properly, because upon receipt of a stop the blanking valve shuts off train line pressure from the train and allows this pressure to drain off of the vent valve. With a train this takes longer to do than it does on a light engine, but the engineman or maintainer can immediately tell when the blanking valve opens as a surge of air will come from the reset valve.

The action in resetting the valve magnet is as follows: Attached to the bottom of the reset valve is an arm called the reset arm, which is pivoted at one end. Di-



The Stop Valve and the Circuit Reverser

rectly under the reset valve stem *25* there is a pin which is fixed to engage it when the reset handle is pushed upward. The end of this reset arm has a flat circular piece on it in line with the reset spindle *3* of the valve magnet. This reset spindle is arranged to slide easily upwards, and is held down constantly by a compression spring *5* in the stem of the magnet cap. When the reset handle is pushed upward valve stem *25* is raised off its seat, and at the same time reset spindle *3* is pushed upwards, which places the armature *o* of the magnet valve closer to the coil. When the armature is close enough for the current to pick it up, the reset handle is released, and pin reset spindle is forced down to its normal position by the reset pin spring *5*. Valve stem *25* is forced

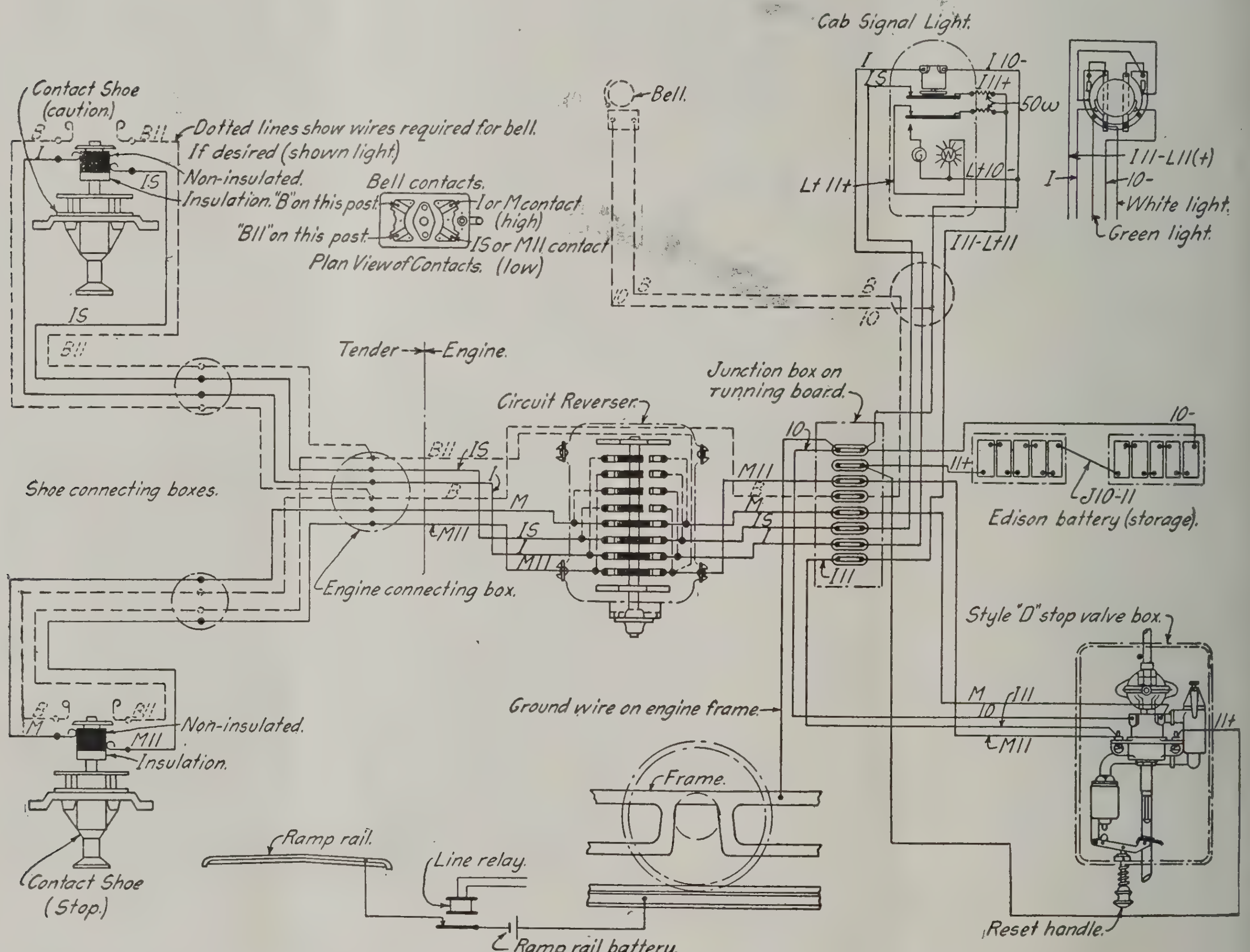
down on its seat by valve stem spring *21*, which stops the leak caused by the raising of the reset handle.

The Engine Circuits

Three circuits are used on the engine. These are the caution, stop and bell circuits (bell circuits optional). The caution circuit takes positive battery from the storage battery on the engine, through wire *11* +, through terminal *11*, to contact on the stop valve apparatus, though wire *I11*, through terminal board over wires *I11-Lt11*, where it splits through two 50-ohm resistances and passes through the contacts of the cab signal relay. The second contact forms a local circuit for the cab light, the white light being energized through the front contact, caution ramp is energized the cab signal circuit is maintained by the passing of positive battery through the ramp to the caution shoe, through wire *I* to the magnet coils of the cab signal and to common.

The stop circuit takes battery through wire *11* +, through terminal *11*, thence over wire *11* +, through contacts on the stop valve apparatus, through wire *M11*, through the terminal board and circuit reverser, through contact *M11* to the drum on the contact stop of the shoe, thence through drum to contact *M*, over wire *M*, circuit reversers, and terminal board to one side of the electro-pneumatic magnet valve on the stop valve apparatus, thence through wire *10* to common.

Should the stop ramp be de-energized the stop circuit

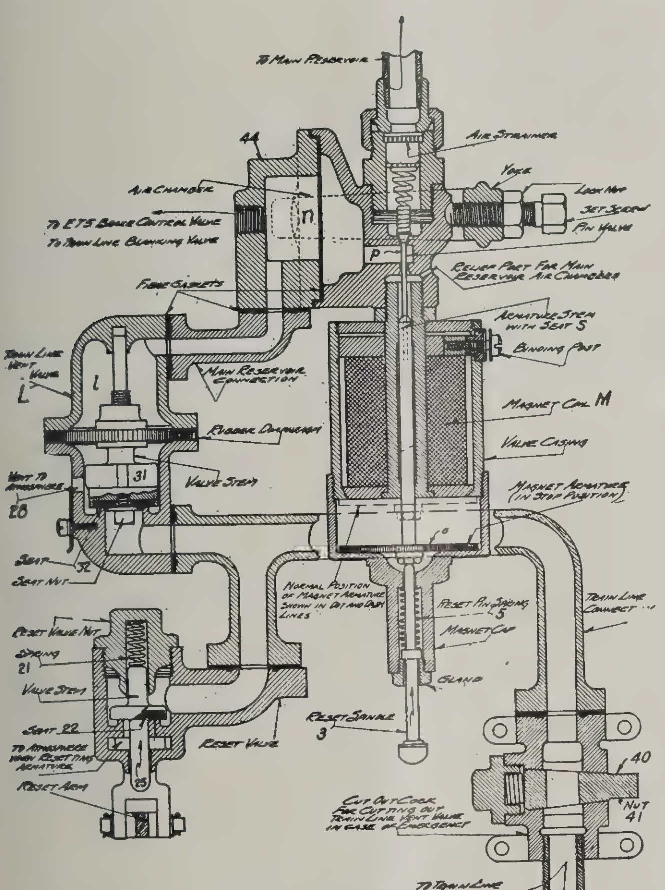


The Engine Wiring, Showing the Caution, Stop, Bell and Cab Signal Circuits

while the green light is energized through the back contact as shown. The wire *IS* is then carried through the front point of the first contact, through the terminal board through the circuit reverser and the engine connections to the contact *IS* on the engine shoe. The current is then carried to the contact drum on the engine shoe through wire *I* back to one side of the magnet on the cab signal relay and through the coils to common. Should the caution ramp be de-energized when the shoe passes over it this circuit is broken at the point *IS* on the shoe and the green light of the cab signal is lighted up through the back point on the second contact. If the is broken on the shoe at the contact point *M11*. On passing over a non-electrified stop ramp rail the contact shoe will, in raising, operate the circuit controller attached to the plunger, thus interrupting the normal electrical locomotive circuit, causing the armature of valve magnet *M* of the stop valve to assume the position shown in the cross section of the stop valve apparatus. When the valve magnet armature *o* drops to the position shown pin valve *p* will seat and close off main reservoir pressure from chamber *n* of valve magnet body, thereby causing valves in blanking valve *E* or brake control valve *D* to seat and relieving the pressure from the diaphragm of

vent valve L, causing train line pressure to exhaust to atmosphere through ports m-m in vent valve L, producing the desired train line reduction. When the stop ramp rail is energized the valve magnet M of the stop valve apparatus is held energized by positive battery through a point on the line relay, through the ramp rail, through the contact shoe and contact drum on the shoe through wire M, through the circuit reverser and terminal board to one side of the electro-magnet M and from there over wire *10* to frame of the locomotive, thus completing the circuit and maintaining this valve in the energized position, which prevents a stop being made. The bell circuit is a simple local circuit as shown by dotted lines on the diagram.

The engine apparatus or "shoe" is fixed to the frame

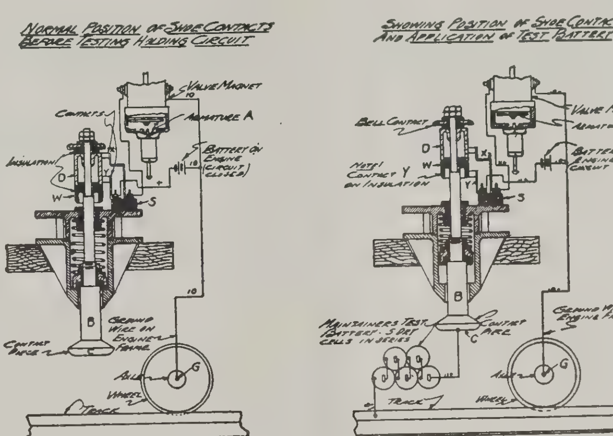


Cross Section of Stop Apparatus

of the front truck of the tender, each ramp causing an upward movement of the "shoe." A battery on the roadside conveys current to the ramp, and with the ramp energized, this current is carried by the shoe to the apparatus on the locomotive; and by controlling electric magnets it prevents the application of the brakes at the stop ramps and the giving of the cautionary signal in the cab at cautionary ramps. With the ramp de-energized, the lifting of the shoe opens a circuit, de-energizing a magnet; and thus air is exhausted from the train line so as to apply the brakes. The bottom of the contact shoe is in the form of a circular disk, and is arranged so as to make contact even when a little out of line. The ramp, without regard to whether the indication is or is ⅜ in. by 3 in. by 3 in. and is mounted on a 6-in. sleeper bolted to the ties.

A vibrating bell in the cab is arranged to sound whenever the shoe rises as much as ¼ in., so that the engineman thus receives notice every time a shoe goes over a ramp, without regard to whether the indication is or is not against him. If the vertical movable member of the shoe is broken there is provision made for opening the train line and applying the brakes; if it is bent the first contact with a ramp will tend to cause it to stick in its upward position, thus causing a continual ringing of the bell in the cab. If the shoe should be broken off completely the electrical connections would be broken so as to cause application of the brakes.

To provide for running in either direction and also to provide for using the left hand apparatus in place of the right hand, or vice versa, all of the wires on the locomotive are run through a box containing circuit reversers. Thus in case either shoe is lost or disabled the engineman, by a single operation, can change all of the circuits and substitute either shoe for the other. The cab signal has a proceed light and a cautionary light, but none for stop; but always on the dropping of the stop



Shoe Circuit and Method of Testing

valve both lights go out, thus indicating that an automatic stop contact has been made.

After the brakes have been applied the apparatus can be restored to normal position only by lifting the armature of the stop valve; and this must be done by pushing a knob which can be reached only by a person standing on the ground.

The circuits on the engine are fed normally from a storage battery, of 80 a. h. capacity. The normal voltage is from 10 to 12 volts, furnished by 10 cells of this battery mounted on the running board. A permissive movement may be made over a ramp providing the speed has been reduced to a predetermined limit and in addition the engineman presses the button while passing over the ramp. Provision has also been made for an automatic cutting off of the bleeding of the train line when a reduction to 25 lb. has been made, thereby lessening the time of stopping, as it is not necessary to pump up the entire train line.

The official result of the general census of 1921 gives the population of France, including Alsace-Lorraine, as 39,402,739, of which 1,550,449 are foreigners. The population in 1920 was 39,604,992, including 1,132,696 foreigners.

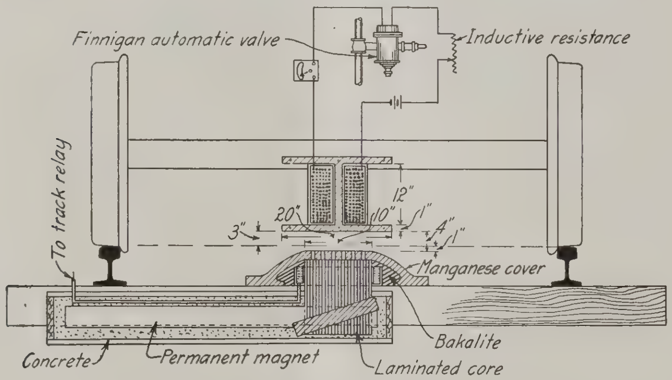
Finnigan Automatic Train Control

George P. Finnigan, of Richmond, Va., who made extensive experiments on the Interborough Rapid Transit Lines in New York City, in 1910 and 1911, and later for two years on the Pennsylvania Railroad between New York and Philadelphia, is still in the field, and his design of train control apparatus, which was the first to employ a permanent magnet on the roadway, is well known to many signal engineers. He has no installation in service at the present time, but he has favored us with a drawing which illustrates the main principle of his system. This we shall briefly describe.

The permanent magnet is fixed in a wooden box, at the level of the ties, and surrounded by cement. The box is about 5 in. by 6 in. and about 4 ft. long, extending from the center of the track to the end of the tie at one side. The winding of the electro-magnet on the roadway surrounds a laminated pole piece which extends upward, the top of the outer case being at a height 1 inch lower than the tops of the running rails. This winding is energized by the track relay of the section to be protected.

The iron bar shown in an inclined position clamps the pole piece to the permanent magnet. This apparatus is fully waterproofed.

The collector coil on the locomotive passes at from 4 in. to 6 in. above the roadway box. This collector coil



Circuit Diagrams of Finnigan Device

is a part of a closed circuit energized by a battery consisting of a single dry cell, which controls the Finnigan automatic air valve, shown at the top of the drawing. The inductive resistance in this circuit, shown at the right of the drawing, is adjustable and its function is to determine at what speed the train may pass a control point without an application of the brakes. The roadway apparatus is, of course, located full braking distance to the rear of the entrance of the section which is to be protected.

Assuming a train approaching a control point when the track relay governing this roadway magnet is closed (section ahead clear), the current in the electro-magnet diverts the lines of force of the permanent magnet so that they do not affect the engine coil (at any speed).

With the governing track relay opened (section ahead occupied by a train) the flux of the permanent magnet causes the application of the brakes. It acts on the engine-carried collector coil and affects the engine circuit according to the speed of the train, the number of turns of wire in the collector coil, and the number of lines of force from the permanent magnet cut by the engine-carried coil.

Assuming that trains are not to be stopped unless they are moving at five miles an hour or over; assuming also that at that speed the train generates 1½ volts and that the engine battery has a potential of 1½ volts, the e. m. f. generated in the train circuit by the passage of the train will cause the battery to react and the air valve will function. At any speed below 5 miles an hour, the e. m. f. generated will be insufficient to affect the engine-carried battery and no brake application takes place.

It will be noted that all these operations take place without requiring the movement of any part, or the opening or closing of any electric contact.

Recent Developments in the Use of Concrete Poles on Railroads

The last few years have witnessed a considerable interest on the part of the railroads in the use of reinforced concrete poles and other similar structures, particularly where the requirements of low cost and utility are coupled with a desire for architectural treatment. In this connection, therefore, it is of interest to note the type of pole recently installed by the Pere Marquette at its depot at Belding, Mich.


The Posts at Belding

These standards were furnished by the Massey Concrete Products Corporation, Chicago. They are 13 ft. high, of hexagonal cross-section, and embody what is known as the Hollowspun type of construction, the essential feature of which is the placing of a wet mixture of concrete in a form containing the reinforcing steel and revolving at a high rate of speed, an operation which not only serves to compact the concrete around the reinforcing steel but also to leave a cylindrical opening throughout the length of the pole, thereby reducing the weight and the attendant inconvenience of handling. The type of pole used in this case is shown in the accompanying illustration.

A similar type of lighting standard, though shorter in length, has been developed by the same company for mounting on bridge railings, and poles of the same construction, though circular in section, have recently been installed on several railroads as bridge warnin gupports. Examples of the latter are to be found in the poles used on the Illinois Central bridge over the Kankakee River at Kankakee, Ill., also the poles erected on the Pennsylvania at Philadelphia, the New York Central at Lyons, N. Y., and in the electrified zone of the Norfolk & Western near Norfolk, Va.

More than 25,000,000 tons of patent fuel are being made in Germany every year, against less than 2,000,000 tons in the United Kingdom.

There are 600 motor trucking companies in Great Britain. Some carry freight for distances of over 100 miles at a lower rate than the railroads.

National Safety Appliance Company's System

A Train Control Device of the Induction Type Using Permanent Magnets on Track and Locomotive

THIS system is of the intermittent induction type, employs permanent magnets on both track and train.

An installation is now in service operation on the line of the Southern Pacific immediately east of Hayward, Cal. This installation covers about five miles of single track and provides automatic stops and intermittent speed control. Two passenger and two freight engines are equipped with the automatic safety apparatus. The scheduled train movement over this territory consists of 15 passenger and four freight trains daily.

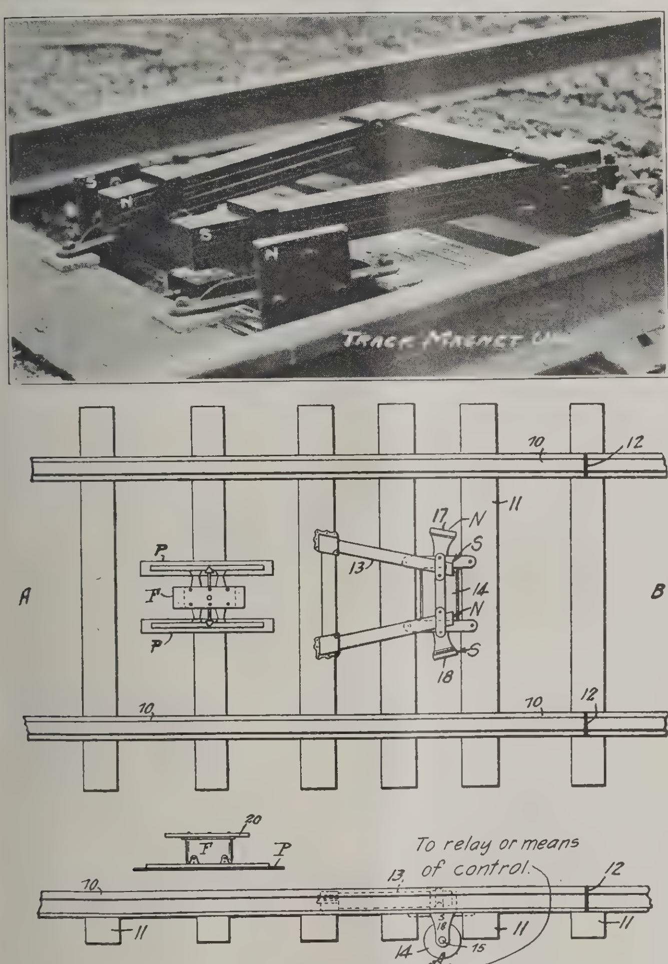


Fig. 1—Photograph and Diagram of a Track Magnet Installation

The system is designed as an adjunct to fixed block or interlocking signal systems, is constructed for interconnection with such signal systems, and its operation is controlled in the same way. Automatic stop operation is caused whenever a condition is produced which would cause a standard automatic signal to assume the stop position and should the engineman fail to obey the fixed signal indication. It is also operative when the signals are actuated manually, in this instance suitable circuits along the track being provided to control the operation of the electro-control magnet.

Actuation from the track to the train is by means of magnetic induction. The track apparatus lies wholly below the upper surface of the track rails. Clearance between track apparatus and that on the train is from five to six inches and there is no mechanical contact.

The appliances are four only:

On the engine: Magnet control valve unit.
Pneumatic stop valve.
Release and double-heading cock.

On the track: A permanent maget, controlled electrically

The track permanent magnet normally operates to stop trains. Automatic-stop operation is positive when track conditions would cause a stop signal and should the engineman fail to obey the indication. Operation on the train is pneumatic solely and is entirely automatic for train movements in either direction. Release after an automatic application is the only manual operation. Intermittent speed control is provided from the track and as may be desired for control to any predetermined speed at distant signals, at curves and at any restricted speed territory; also for control of speed to the maximum speed restriction of the railroad upon which the system is installed.

Engineering Description of the System

The track apparatus consists of a permanent magnet, *13*, Fig. 1, mounted on the ties in the center of the track, its length paralleling the rails, and its upper surface being preferably about one inch below the upper surface of the rails. An electro-magnet control unit, *14*, with extended pole-pieces, *17-18*, is located below and across the poles of the permanent magnet and is of superior power when energized. Its control is through the track and line circuits of any standard automatic signal system, current from standard signal battery being supplied to the electro-magnet control unit through a local circuit for clear movements only, and only while the train is passing through a short insulated track section, current being cut off when this section is bridged. The control is provided as desired, for either or both directions of traffic. Normally the magnet field of the permanent magnet is in place for automatic stop operation, and it is diverted only for clear movements by energizing the electro-magnet control unit.

The electro-magnet control, *14*, Fig. 1, is adjacent to the poles of the permanent track magnet with the poles reversed with respect to the poles of the permanent magnet to provide a means for deflecting its field, and during such deflection distorting the magnetism of the permanent magnet, thus permitting free passage thereover of the locomotive and train.

Each magneto-control valve, Figs. 2 and 4, consists of two pairs of "U" shaped permanent magnets, M and M′, with pole-pieces *28*, Fig. 3, securely attached. Extensions *25* connect with inductor planes, *P* extending parallel to the longitudinal axis of the engine tender, so that they pass directly over the pole pieces of the track mag-

nets, at a clearance of 5 or 6 inches. The two pairs are oppositely placed with reference to their polarities.

The valve proper is a brass casting, *40*, with steel pole pieces fitting in the recesses *51*, and extending through the horizontal lugs on the pole pieces *28*. A valve stem, *46*, carries on its upper end an armature, *45*, which rests on the pole pieces above mentioned. A leather gasket, *62*, with a small centrally located hole is held against a seat in the valve by a bushing, *63*. The lower end of the valve stem rests against this leather gasket. Main reservoir air is admitted through passage *79*, strainer *74* and port *80* to the chamber in the bushing *63* beneath the gasket *62*, which forces it against the lower end of the valve stem *46*, thus sealing the opening from passage *79* to the atmosphere and preventing the escape of the air as long as the armature is held against the pole pieces by the permanent magnets M and M′. When the field of these magnets is neutralized by passing over active track magnets, the armature is released and the air escapes from passage *79* to the atmosphere through a port in the valve. The entire valve is protected by a brass casing which provides the air passage *79* and holds the valve *40* tightly against the pole pieces. Passage *79*, Fig. 2, is connected by pipe *730* through the double-heading valve E to the brake application or stop valve D.

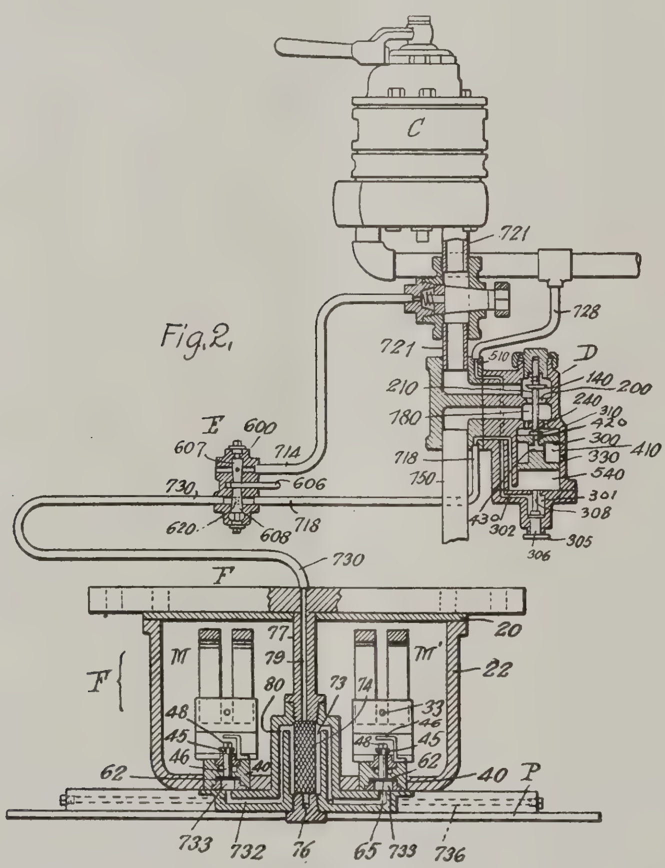


Fig. 2—Diagrammatic Illustration of Magnet Control Valve Unit. Pneumatic Stop Valve and Release and Double Heading Cock

The stop valve as shown in Fig. 2 is combined with the non-release valve and consists of a spool-shaped piston, *300*, moving vertically in a chamber, *410*, which has a vent, *330*, to the atmosphere from the central space between the flanges of the piston. The piston has a chamber, *420*, extending axially from its upper surfaces connected by radial ports, *430*, to the chamber between its flanges. The piston moves freely but is so adjusted that when raised it engages the piston rod, *210*, of the poppet valve, *140*, working in a chamber above. Where it engages the spool-shaped piston it forms a valve, *240*, which closes the central port of the piston when it is in its upper position. Above the chamber occupied by the spool-shaped valve are two chambers separated by a diaphragm, which forms a seat for the poppet valve above mentioned. This valve, forming the non-release feature

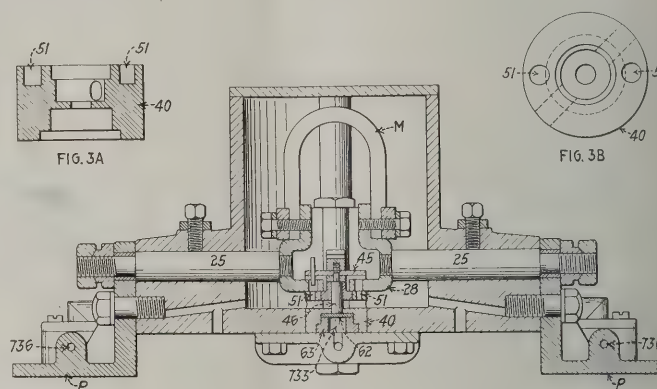


FIG.3

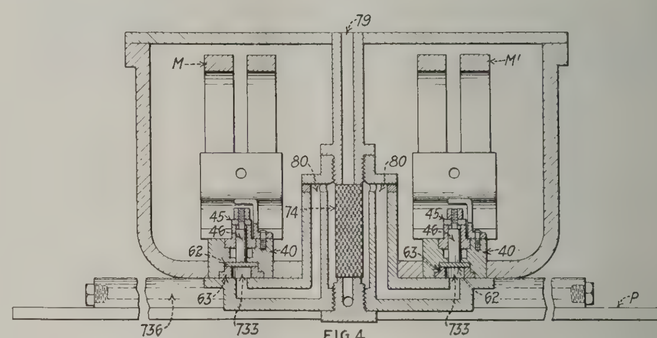


Fig. 3 and 4—Cross-Section on Magnet Control Valve Unit

of the train-control valve, when opened, provides a free passage from the train line to the engineman's brake valve through connections *721* and *150*. Train line pressure, admitted to the chamber above the spool-shaped piston by ports from the chamber directly above, tends to force piston *300* down, but is resisted by main reservoir pressure on the lower surface admitted through connection *728* and port *302*.

A connection, *718*, leads from chamber *301*, connecting with chamber *540* through the double-heading and release cock, and connects with the central core *79* of the casing referred to.

When the field of one pair of the engine magnets is neutralized by passing over an active track magnet—which affects the engine magnets of polarity opposite to itself—air is exhausted from chamber *420*, through the connection *718*. Train line pressure above piston *300* forces it down and allows the valve *240* to open, thus permitting the train line to be vented through chamber *420* and piston valve chamber *410* and ports *330* to atmosphere. On account of poppet valve, *140*, being now closed, the engineman cannot increase the pressure in the train line. After the valve has operated as above described and the engine has passed outside of the field of the track magnets, the double-heading release cock

is operated, which closes the connection in pipe *718* between chambers *540* and port *79*, relieving the pressure on the end of the valve stem so that gravity, assisted by the magnets, may bring it back to the seat. The lever *606* is then restored to normal position, which allows the pressure from the main reservoir to build up in chamber *540*, forcing piston *300* to normal position and opening valve *140*. Lever *606* must be restored to normal position, for while reversed a connection is opened from a double-heading cock to pipe *79* to the atmosphere, which will cause the brakes to be applied as long as the lever *606* is in reversed position.

The track is divided, as usual, into a series of blocks insulated from each other. A single permanent track magnet associated with an electro-magnet or solenoid of opposite polarity is suitably installed within or at the entrance of each block in an insulated track section of two or more rail lengths. The track magnet acting alone is capable of controlling the operation of the train stopping means carried by the train every time a train passes over

Fig. 5—Receiving Unit on the Locomotive

the magnet, since it has a polarity opposite to that of one of the valve magnets.

When a train passes over the track magnet its field acts upon the inductor planes of the duplex control valve, F, Fig. 2, which causes a reversal of polarity in one of the armatures thereof and thus permits the release of the armature from the poles installed as heretofore described in the duplex control valve and thereby permits the opening of the valve therein because of the air pressure normally exerted thereon, which action results in the stopping of the train. The electro-magnet control unit, however, is energized whenever its circuit is closed by a train closing the track and line circuits of a system to provide clear signals and thus acts to divert the free field of the track magnet and thereby prevents the track magnet from causing the train stopping mechanism of the train to operate. The installation of the electro-magnet control unit is such that it will be energized on the approach of a train when the block ahead is clear or unoccupied, and its circuit will not be closed by the approach of a train when the block ahead is occupied; thereby permitting the permanent track magnet to act upon the train stopping mechanism. The reason the electro-magnet control unit acts upon the track magnet to divert its field is due to the fact that the former is stronger than the permanent track magnet and its polarity is opposite thereto.

Only one of the magneto-pneumatic control valves is operated at any one time. The magnets of the two valves, as heretofore stated, are so arranged as to be of opposite polarity, that is, the S pole of one and the N pole of the other are in a line parallel to the center line of the track. One of the locomotive magnets is therefore always of a polarity opposite to that of the track magnet, regardless of the direction the locomotive is headed, and also regard-

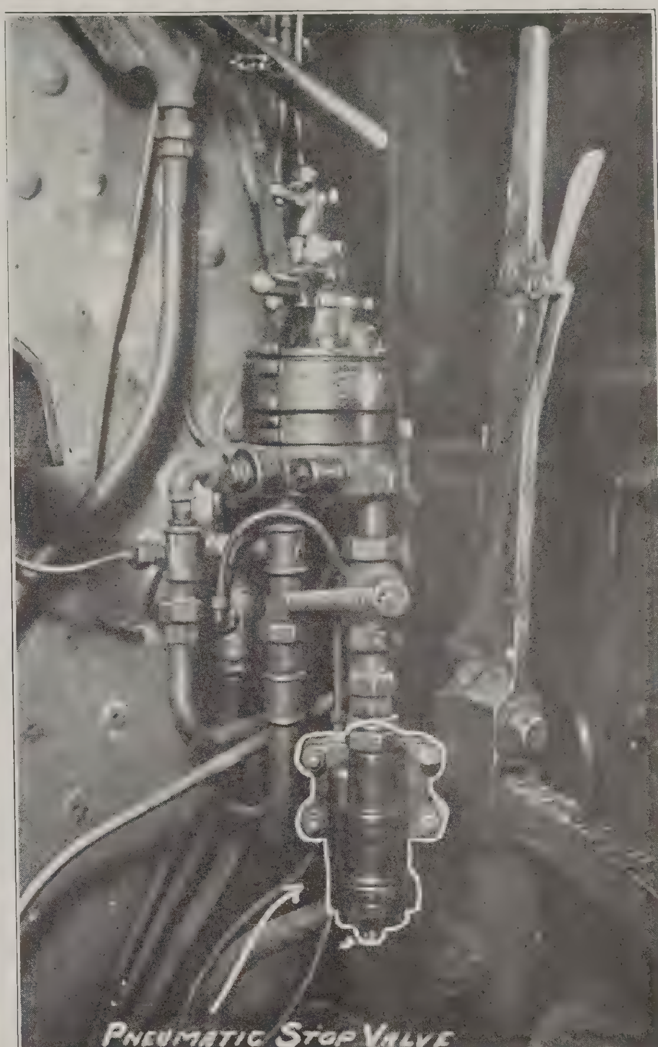


Fig. 6—Pneumatic Stop Valve Attachment to Engine Equipment

less of the position of the track magnet; and the magnet of the duplex valve which is of opposite polarity to the track magnet is the one that is operative.

After the device is operated and the operative field of the track magnet passed by and the train brought to a stop the double-heading lever *606* of the double-heading release cock, E, Fig. 2, is manually moved (for absolute stop from a position outside the cab requiring the engineer to dismount therefrom) to released position. This closes the lower plug cock, cutting off communication from the pipe *718* to the pipe *730* and venting any remaining pressure in the chamber *733* to the atmosphere through the port *620* (in the double-heading cock), this

relieving the pressure on the end of the valve stem, restoring the armature *45* to normal and closing valve *46*.

While the lever *606* is in released position the upper plug cock *607* of the double-heading release valve is open, allowing the brake pipe pressure to flow through the double-heading cock, through the pipe *714* and thence to atmosphere. The lever *606* must be returned to running position for the purpose of closing the exhaust port to this cock, thereby ensuring that the lower cock will be opened and in proper operative position. Failure to do so will leave the brakes still unreleased as the air is exhausting through the pipe *714* and the plug cock *607*.

The returning of the lever *606* to running position allows main reservoir pressure to build up in the chamber *540*, forcing the piston *300* up into the chamber *230*, closing the valve *240* into its seat *310* and raising the valve *140* off of its seat *200*, as above described.

In double-heading, all following engines close the air conduit leading from the engineman's automatic control valve, thus preventing him from operating the train brakes. It is also necessary that the train stops on all following engines be made inoperative and the double-heading release cock, E, provides this means.

When the handle *606* is placed in released or double-heading position the vent pipe air from the stop to the control valves is cut off and the pipe leading from the engineman's control valve is closed first. Should the engineman fail to place the handle *606* of the cock *600* in double-heading release position, the stop will still be operative; should he fail to place the handle *606* in running position after double-heading, his brakes will be applied as soon as he turns the double-heading cock to running position because the brake pipe will be vented through the plug cock *607* of the double-heading release cock E.

Protection is provided against broken indicator planes in the duplex control valve. These indicator planes, P, are constructed of cast iron with a port or air passage *736* running lengthwise thereof. If these planes should get broken, air pressure will be exhausted to the atmosphere and bring about the application of the brakes in exactly the same way as if the valve *46* attached to the armature was open in the regular way.

Electric Switching Service on the New Haven

By F. W. Carter
Westinghouse Electric & Manufacturing Company

Electric switching locomotives are used in four freight yards on the New York, New Haven & Hartford. When the yards were electrified, every three electric locomotives replaced five steam locomotives which had been used for switching service.

The sixteen 80-ton electric switching locomotives are of the single-phase, 25-cycle, 11,000-volt, alternating-current type, having two articulated trucks. The over-all length of these locomotives is approximately 37½ ft. They have a tractive effort of about 23,200 lb. with a horsepower rating of 752, and a maximum speed of 25 miles per hour. Each locomotive has four motors geared to the axles. The diameter of the drivers is 63 in.

Five of these locomotives are located at the Oak Point yards, two at the Westchester yards, two at the Stamford yards, three at the Harlem river yards, one used for transfer of freight on the New York, Westchester & Boston Railway, and the remaining three held at the shops for inspection or use at whatever point the service demands.

The three main electrically equipped yards on the New Haven are the Oak Point yard, having a length of about 37 miles, with a total of 35.5 miles of electrified track; the Harlem river yard, having a length of about 23 miles; and the Westchester yard, with about the same trackage as the Harlem river yard.

The number of electric switching locomotives assigned to the Oak Point yard varies at times from five to seven, according to the amount of traffic to be handled. The locomotives in this yard are used in two different classes of service, four of them being assigned to what is known as "float yard" service, to unload eastbound cars from the floats and to load westbound cars on floats, and also to do whatever switching is necessary with the westbound cars. The New Haven has approximately 16 tug boats with from 350 to 1,200 horsepower each for transporting the freight cars between the terminals by floats, the floats having a carrying capacity of from 12 to 22 cars each. The fifth locomotive used in these yards takes the eastbound cars from the float yard to the classification yard and makes up the eastbound trains. In looking over the records one month was selected as a representative month, which showed an average of 43 floats handled daily at the Oak Point yards. With an average tonnage of 900 for the eastbound float loads, and 600 for the westbound, the four locomotives assigned to the float yards handle approximately 16,000 tons each in a 24-hour service. The locomotive working in the classification yards handles about 75 per cent of the eastbound cars received, the other 25 per cent being taken to the Westchester yards by the transfer engines. This makes the average daily tonnage for these locomotives approximately 18,000. In addition to loading and unloading the floats the four locomotives in the float yard do a certain amount of switching of westbound cars and various miscellaneous work in the yards. The figure of 18,000 tons, therefore, seems to be a very fair average tonnage for the locomotives which are working in this yard.

The following is the monthly mileage made by some of these locomotives in switching service:

Locomotive No. 0202 — 4,356 miles per month
Locomotive No. 0203 — 4,446 miles per month
Locomotive No. 0204 — 4,392 miles per month
Locomotive No. 0208 — 4,320 miles per month
Locomotive No. 0214 — 4,404 miles per month

The locomotives are kept in service 24 hours a day by using three 8-hour crew shifts, and after the completion of 2,500 miles they are sent to the Van Nest shops for a light inspection. A day force working eight hours is employed for locomotive inspection and the work is usually done at the rate of two locomotives per day.

A number of these electric locomotives have made records of 24 hours a day for 30 days without any interruption.

The principal advantages ascribed to electric locomotives in switching service are that they conserve the fuel supply, affect car-mile economies, expedite the operation of trains and reduce the number of locomotives required to do the work.

Electric Tractors and Trailers for Short Hauls

The New Haven Railroad Departs from Usual Methods in Handling L. C. L. Freight at Boston

THE use of tractors and trailers for hauls which rarely exceed 100 ft. is the outstanding feature of the methods followed by the New York, New Haven & Hartford in the operation of the outbound houses of its Boston, Mass., freight terminal. Ordinarily, operating officers associate the use of the tractor-trailer system of handling freight with long hauls. Therefore, considerable interest is attached to the Boston installation, where the hauls are decidedly short.

The Boston freight terminal is almost exclusively a city freight proposition, the transfer tonnage amounting only to a negligible 3 per cent of the total tonnage handled. In normal times the operation of this terminal involves five outbound houses containing 111,000 sq. ft. and seven inbound houses having 234,000 sq. ft., and four piers with 650,000 sq. ft., an approximate total of 1,000,000 sq. ft. of floor space for the entire terminal. A 300-car set-up can be taken care of readily at the five outbound houses and, at various times, more than 400 cars have been loaded through the outbound houses and piers in one day, while 200 cars were unloaded into the inbound house in the same time.

Tractors and trailers are used only for the handling of outbound freight. At present, owing to the business depression, all such freight is handled through houses No. 1 and No. 6, the largest of the five outbound houses. Each of these two houses is 810 ft. long and 40 ft. wide, with platforms 150 ft. long and 175 ft. long, respectively, provided at one end. These platforms are utilized in the receipt of freight, the total area of the platforms being 7,800 sq. ft.

No. 1 house is served by four tracks and No. 6 house with five tracks. The present daily set-up at No. 1 house consists of 76 cars with an average daily tonnage of 530 tons, while at No. 6 house the daily set-up involves 120 cars and 800 tons of freight.

Each of the two houses is provided with 52 doors on the driveway or the receiving side, and 20 doors on the track or loading side of the houses. Thus it will be seen that the operation is funnel shaped, with the small end towards the cars, making it necessary to handle through the 20 rear doors, and into the cars, the tonnage unloaded by teamsters through the 52 front doors.

The plan of operation in the two houses is predicated on securing a direct haul from the teamster's trucks, through the house and into the proper car, avoiding longitudinal movements through the house wherever possible. To this end cars for a particular destination are always spotted at the same location and directly across the house from the door or doors assigned for the receipt of shipments for the particular destination. In other words, No. 1 house is designated as the house which will receive shipments for certain destinations, while No. 6 receives only freight for certain other destinations. Outbound shipments must be delivered to designated houses at points within a reasonable distance of the proper door. In this way confusion and congestion resulting from crossing traffic are eliminated. Sufficient variation in deliveries is, of course, permitted to avoid the stopping of teams at an excessive number of doors. The arrangement is subscribed to by the drivers who co-operate by loading their trucks by house and door destination, as far as possible, following instruction books furnished by the railroad.

It is obvious that with the short hauls from the point where freight is delivered to the railroad to the destination car, which result from this plan, the arrangement is advantageous to the shipping public inasmuch as it is possible to receive freight until a late hour in the afternoon and still get it loaded for movement that night. But, formerly, even with this apparently desirable arrangement doors and floors become blocked with freight, especially in the late hours of the afternoon, since approximately 60 per cent of the outbound tonnage is offered between 2 p. m. and 5 p. m.

The former method of receiving freight, in effect prior to July, 1918, was to accept all outbound freight at the assigned doors as dropped on the floor by the teamsters. The freight was then checked up by the receiving clerks who signed the bills of lading. In order to keep the doorways clear it was necessary to move the freight back into the house to await rechecking and loading. This moving back of the freight was done by the doormen who used hand trucks for this work. The loading into the cars was done by the so-called gang system after a rechecking of the shipment against the shipping order.

In July, 1918, the operating plan was changed and manually operated drop-trucks were installed. Under this plan four-wheel trucks were provided and placed at the receiving doorways. This enabled the teamsters to unload from their trucks direct to the drop-trucks, thus keeping the freight off the house floor. Doormen, reduced 50 per cent in number, kept a sufficient number of trucks at the doors while a tally-man checked the number of packages, chalked the freight with the number of the outbound car and signed the bill of lading, thus eliminating one check and one handling of freight. The loaded trucks were then pushed away from the doorway and subsequently were pulled into the cars by laborers assigned to that duty.

Results of Tractor-Trailer Operation

While prior to the introduction of the present system approximately 10 per cent of the outbound freight was held over daily because of the inability to clean up, it has been possible, since the installation of the tractors and trailers, to keep the floor free of freight. The necessity of pushing freight back into the house has been eliminated under the new plan and a substantial saving in wages paid to labor has also been effected. Furthermore, the likelihood of loss and damage incident to the pulling down and overhauling freight standing on the floor in order to load complete shipments without splitting them up, has been obviated. A decided improvement also has been made possible in the billing department through the ability to deliver shipping orders earlier, thus reducing the likelihood of error and omission resulting from the hurry in-

cident to train departure. In addition the cost of handling outbound tonnage has decreased from 67 cents per ton in July, 1921, to 50 cents per ton as a result of the tractor-trailer operation.

With the tractor-trailer operation in the two 40 ft. wide houses which load to four and five strings of cars, with the freight received nearly opposite the car, and with an approximate haul of 100 ft. the houses have at all times been kept clear of congestion and there is no freight on the floor to run around except certain bulky articles which the present 15 in. high trailers cannot accommodate. Trailers 11 in. high from floor have been ordered to afford lower trucks on which to handle such bulky freight as barrels, bales, etc.

The house equipment includes a charging station in each house operated. The tractors are put on charge by a freight house man at the close of the day. A second class electrician, reporting at 11 p. m., is responsible for their proper operating condition. No. 1 house, handling 530 tons of freight, requires two tractors and 120 trailers, while No. 6 house, with 800 tons, has three tractors and 180 trailers.

Empty trailers are always kept at the freight house doors and are loaded by the teamsters and one freight house man. A separate trailer is given each shipment regardless of size and, after the block number has been chalked on the freight, the truck is moved by the tractor to designated car.

There are two men on the tractors; a driver and helper. The latter makes the hitches and steers the trailer when it is being pushed. At Boston pushing, rather than trailing, is the prevailing method of procedure because of the short haul and the absence of any turn around platform on the farther side of the cars. The tractor will turn in a car but the push method has been found expedient as the tractor, after pushing the load into the car, backs out and repeats, keeping busy all the time in one part of the house or another. Stevedores, one for each ten cars, unload the trailers and push the empties back into the house.

The Boston freight terminal is operated under the general supervision of G. Marks, assistant to the general manager, and F. S. Hobbs, superintendent. William King, agent, is in direct charge.

Applications and Tests of Large Diameter Electric Welded Pipe*

Engineering research and investigation are continually opening up new fields and new applications of old methods and processes. One of the most rapidly expanding fields is that of autogenous welding. For a number of years following its commercial development the acetylene process was the only one available for this kind of work. However, with the extension of our knowledge of electricity and its application to new and varied operations electric welding became a reality. Of the several electric welding processes that have been developed the "metallic arc" process is perhaps the one most widely used. A large proportion of the "metallic are" welding done up to the present time has been in repairing broken machine frames, building up worn parts, etc. Recently, however, this method has been employed in the fabrication of various finished products and where it has been possible to apply it, a considerable reduction in cost of manufacture has resulted. A particular case of this kind is that of large diameter pipe for low pressure work. There are many uses for such pipe. It has already been used extensively for dredge pipe and low pressure steam lines.

This pipe is made up by rolling flat plates into cylinders of the desired diameter and 5 ft. or more in length. When the pipe is used for steam it was found advisable to bevel the edges. After welding the longitudinal seam several cylinders are welded end to end to make sections of convenient length. For temporary installations, such as dredge pipe, various methods are employed to join sections, while for permanent work, such as low pressure steam lines, the sections are welded end to end in the trench to form a continuous pipe.

The advantages obtained in using such pipe for dredge work are several. In the first place the pipe is lighter in weight than ordinary wrought iron pipe. This is a saving both in original cost, freight, and in cost of handling and installation. Where it is necessary to carry the pipe on supports, a lighter framework can be used. In one large construction job where 30,000 ft. of this pipe was used the pipe was made up in 8-ft. joints and 16-ft. lengths. These sections were provided with a pair of hooks welded to ends of each length. These were tied together with cable or wire. One end of each section was enlarged and slipped over the adjacent section and the joint made tight by driving in shingles. This worked very satisfactorily. The chief engineer on this project has stated that the high carbon electric welded pipe which was used was far ahead of anything that was on the market before and that it has given a service four or five times as long as that of so-called standard dredge pipe which was used almost exclusively heretofore. Another application of welded pipe is in the distributing systems of central heating plants using low pressure steam. The pressure in such systems is generally under 25 lb. per square inch, so that standard pipe of the required size is much heavier than is necessary to withstand the working pressure. For this reason an economy is effected by using welded pipe, which is lighter in weight, easier to handle and lower in cost in larger sizes. It is also generally easier and quicker to make up the welded pipe than it is to buy ordinary steel pipe on the market, especially in the larger sizes.

While the working pressure is low in such installations and the welded joints have ample strength to withstand it, other factors enter which make the requirements quite exacting. In one installation of 22-in. pipe for a district heating plant it was found that the top of the pipe became hotter than the bottom and the differential expansion tended to open up welded seams if expansion joints were not placed at short enough intervals. No trouble was experienced when expansion was taken care of by joints every 125-150 ft., as at alleys and street intersections, and when the welding was properly done as described later.

The method of installing this pipe is unique. A concrete foundation about 6 in. thick is laid in the bottom of the trench and carries the pipe supported on rollers to allow for expansion. Sidewalls of brick are brought up on either side the pipe so that boards laid across the top clear the pipe. The pipe was wrapped with heavy pipe

*A paper prepared by J. H. Nead and R. L. Kenyon and read before the annual meeting of the American Welding Society, New York, April, 1922.

covering. Heavy roofing was wrapped around this, wired on and painted. The space around the pipe is filled with some good heat insulator, such as sawdust or wood shavings. Metal lath is imbeded in a 6-in. cover slab of concrete.

In the course of making this pipe it was found that certain precautions had to be observed in order to obtain satisfactory results, and certain methods of testing were tried out in order to develop a means of differentiating between good and bad electric welds. The main trouble encountered was in persuading welders to "cut" clear through the weld. Every weld which was tested where this was not done was found to be greatly inferior in strength to those properly made.

It was found that satisfactory welds could be obtained by separating the edges to be welded about 1/8 in. and cutting the weld deep and through the plate. When this was done a bead of fused metal was left on the back side of the weld. This was found to be a good index as to whether or not the weld was properly made. Where it is undesirable to have any protrusions of this kind on the inside of the pipe a water cooled copper strip on a mandrel can be held against the inside of the pipe at the weld. This will permit the fused metal "cutting" clear through and yet will give a smooth inside surface to the pipe.

The pipe used in the low pressure steam line installation was made from 1/4-in. Armco Ingot Iron plate on account of the rust resisting property of this material. The flat plates (approximately 5 ft. x 5 ft. 10 in.) were formed to 22-in. diameter. The edges of the plates were beveled to 37½ deg., thus giving a "single V" type weld with a 75 deg. included angle. The longitudinal weld was then made on the 5-ft. sections by the regular "metallic arc" process. The welding outfit was of the motor-generator type. The voltage across the arc was 20 volts and the current averaged 160 amperes. Armco ingot iron electric welding rods, 3/16 in. diameter, were used for this work, the 5-ft. sections were welded end to end in the shop, in sets of four, the circumferential welds being made in the same manner as the longitudinal welds. In installing this pipe the 20-ft. sections, thus made, were welded end to end in the trench.

For test purposes samples were cut from the 5-ft. lengths already described. Samples 9 in. in length were prepared from a section in which the weld did not "cut through." Similar pieces were cut from another section which had been properly welded by the method just described. For purposes of comparison another 5-ft. section was made up by oxyacetylene welding and cut into 9-in. lengths for test. The heavy plate is placed between the test section and the head of the testing machine so as to flatten the cylinder as the head is brought down. After running the head down as far as possible it was raised and the flattened section drawn back under the head so as to concentrate the load on the weld. While in this position the load was raised to 68,000 lb. in all cases. The electric welded pipe flattened down somewhat more than the gas welded pipe, but this may have been due to the slightly greater width of the gas weld. In neither the gas nor the electric weld did fracture occur in the weld metal, both opened up slightly, but the fracture was in the affected area adjacent to the weld rather than in the weld proper.

One oxyacetylene and one properly electric welded section were crushed down with a 1-in. block inside the pipe near the weld so as to get the same amount of distortion on each. A load of 68,000 lb. was applied to each as before. In neither case did fracture occur.

In these tests the inside of the pipe was subject to compression and the outside to tension stresses. As the difference in properly and improperly made electric welds seemed largely to be a case of "cutting through," another test was applied which placed the inside of the pipe in tension. This, as was expected, readily showed up any difference in strength of the welds due to not "cutting through." Specimens were prepared by cutting pieces from the welded sections, 6 in. long and 2½ in. wide with the weld at the center of the 6-in. length. Three such samples were prepared from the oxyacetylene welded pip and three each from the properly electric welded and poorly electric welded sections. These were tested according to the recommended practice of the American Welding Society for bend tests.

As the data taken in this test give some quantitative measure of the difference between good and bad electric welds, the results are given in the following table:

		At First Crack		At Maximum Load			
	Sample No.	Angle (Deg.)	Load (Lbs.)	Angle (Deg.)	Load (Lbs.)	Average Maximum Load (Lbs.)	Remarks
Poorly made electric weld (not cut through)	1	..	....	27	2,970	....	
	2	31	3,800	38	4,450	....	Sudden crack through weld at maximum
	3	41	4,830	77	6,430	....	
	Av.	..	....	..	....	4,620	
Properly made electric weld (well cut through)	1	..	....	..	9,170	....	These welds slipped to one side in test. Did not crack.
	2	..	....	..	9,830	....	
	3	..	....	..	10,610	....	
	Av.	..	....	..	....	9,870	
Oxyacetylene weld	1	59	6,480	..	7,450	....	This weld was not entirely cut through
	2	..	....	..	8,440	....	Cut through. Fairly good weld. Slipped to one side. No crack.
	3	47	5,920	96	10,200	....	Only No. 2 and No. 3 included in this average, as No. 1 was not "cut through."
	Av.	..	....	..	....	9,320	

These bend tests brought out clearly the superiority of the good electric over the poor electric welds and showed the good electric and good gas welds to be about on a par. The poor electric welds were less than half as strong as good electric or good acetylene welds.

The tests also show that single V electric welds, to be properly made, must have the weld metal cut through and form a bead on the under side. Unless this is done the weld will be very deficient in strength and ductility.

As a check on this test, 20-ft. lengths of pipe were tested under 105 lb. per square inch hydraulic pressure before installation and it was found that tight joints were obtained where the welds were well "cut through," as has been described.

Attention is called to the fact that the dredge pipe and steam heating pipe described was welded by hand by the ordinary "metallic arc" process, and at a saving in cost to the user over standard steel pipe. Automatic welding machines are being developed and with their application to this type of work a still greater reduction in cost should result.

Of the numerous applications of this pipe, only two have been mentioned. The two actual installations cited are evidence of the advantages obtained by its use in place of standard steel pipe. No doubt other uses will be developed as these advantages become better known.

Guard for Automatic Switch Connector

By E. R. Chinberg

When the Rock Island lines adopted the 37-volt potential coil setting for car lighting regulators used in connection with lead batteries, difficulty was at once experienced in maintaining the setting of the Safety Car Heating and Lighting Company's type D automatic

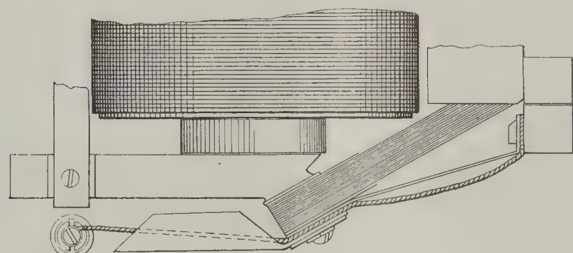


FIG. A

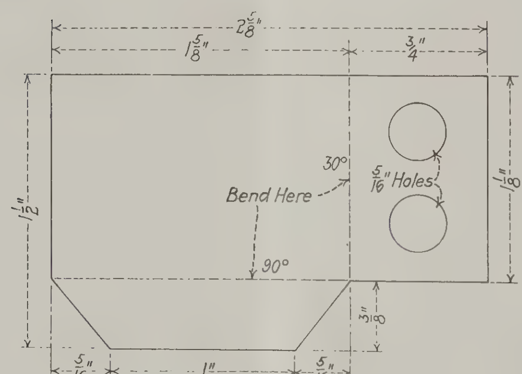


FIG. B

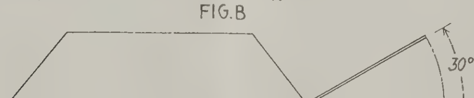


FIG. C

Details of Guard Construction and Application

switch within the limits necessitated by the lower potential coil setting, that is, between 32 and 37 volts.

This difficulty was caused by the flexible connector on the automatic switch which it was found could be manipulated so as to vary the switch setting within a range of seven volts. Unfortunately, the setting would not remain constant. In motoring the generator in different yards or inspecting the automatic switch contacts, the position of the flexible connector was altered and the switch setting was changed.

This proved to be serious and light failures resulted, due to the automatic switch setting being unknowingly changed to above that of the potential coil setting.

To overcome this difficulty several methods were used with varying degrees of success, of which the guard as shown in Fig. "A" was found to overcome the difficulty better than any other method. It also had the advantage of being inexpensive, easily made and applied. When in place it prevents anyone from touching the connector and in all ordinary work of inspection and repairs to the automatic switch the position of the connector cannot be changed enough to seriously affect the setting of the switch.

The guard should be applied next to the flexible connector and can be properly insulated from the armature without any change or additional insulating material. It should be made from 18 gauge iron, cut, bent and drilled in accordance with dimensions as shown in Figs. "B" and "C."

This is an Old One But Still Has the Kick

The following complaint was received by a claim agent of the Illinois Central Railroad, at Vicksburg, Miss., from a Franklin County, Miss., farmer whose hog was killed by an Illinois Central train:

My razorback strolled your track
  A week ago today.
Your twenty-nine came down the line
  And snuffed his life away.
You can't blame me; the hog, you see,
  Slipt through a cattle-gate,
So kindly pen a check for ten,
  This debt to liquidate.

This is the reply received by the farmer:

Old twenty-nine came down the line
  And killed your hog, we know;
But razorbacks on railroad-tracks
  Quite often meet with woe.
Therefore, my friend, we cannot send
  The check for which you pine.
Just plant the dead; place o'er his head:
  "Here lies a foolish swine."

Two Conductors

Jim is a cheery man. Passengers on the 8:15 brighten up at his greeting. To have Jim punch your ticket is to get a good day's start. Old commuters whom he calls by name bristle with pride.

On the 8:27 is another conductor. His name is No. 444. At least, no one knows his name or wants to. He is brusquely efficient. He says "Tickets, please," in such

a way that the "please" sounds like a cuss word. Timid women passengers give him an unfailing chance to raise his voice and roar. The folks who ride with No. 444 are always talking about a committee to fight the railroad—fight it about increased fares, bad service, anything.

Jim and No. 444 both work at the same salary. One of them costs the road more than it could afford to pay its president.

Lil' Ol' Red Caboose

I'm just an old tail ender,
That's tied to the end of a freight.
And I swing when I'm on my way
With the train that's seldom late.
I have to give way to the Pullman
That carries the traveling throng.
And I follow the loaded box car
That rumbles and grumbles along.
But there isn't a car in the outfit
That ever was put in use,
That means so much to a railroad man
As the little old red caboose.

That's What They All Say

"I can't keep the visitors from coming up," said the office boy, dejectedly, to the president. "When I say you're out, they simply say they must see you."

"Well," said the president, "just tell them that's what they all say."

That afternoon there called at the office a young lady. The boy assured her it was impossible to see the president.

"But I am his wife," said the lady.

"Oh, that's what they all say," said the boy.

Not What He Meant

The Boss.—"What do you mean by such language? Are you the manager here or am I?"

Jones.—"I know I'm not the manager."

The Boss.—"Very well, then, if you are not the manager, why do you talk like an idiot?"

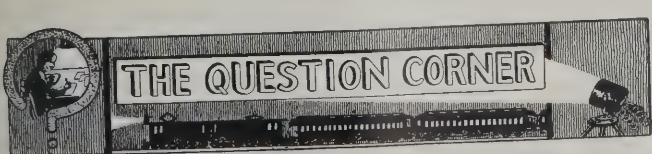
A train dispatcher's life in the winter time in these more or less northern states is a gay one. Read:

"Stuck in the snow, please advise."

"Water tank frozen up, will have to run for water."

"Eng. dead on main line, please advise."

"Train frozen up, unable to get it started."



Answers to Last Month's Questions

1. *The copper loss in a line is 36,000 watts, and there are four consumers on this circuit, each requiring 3,000 watts; (a) would the 3,000 watts consumed by each of them be included in the 36,000 and be considered as consumed by the conductors, or would this be additional power to be furnished by the power house? (b) If the voltage of the circuit was increased from 600 to 1,200 volts, with 60 amperes and the line resistance 20 ohms, would this increase in voltage burn out the apparatus if the wiring was of proper size to carry 60 amperes? (c) Then, is it the increase in current and not voltage which would cause this trouble if the wire was of correct size to carry current?—C. R. E.*

* * *

(a) In answer to the question of C. R. E. in the April issue of the *Railway Electrical Engineer* on page 137, the 3,000 watts used by each of the four consumers would not be considered as copper loss, but the current used by them would contribute to the line loss and would need to be taken into consideration when calculating the size line to use. The line loss in voltage is equal to the resistance of the line multiplied by the amperes flowing.

(b) If the voltage was increased from 600 to 1,200 volts, with 60 amperes and a line resistance of 20 ohms, the increase in voltage would not burn out the apparatus if the wiring was of proper size to carry 60 amperes.

(c) It is the increase in current and not in voltage which would cause this trouble. Of course, an increase in voltage would cause more current to flow through a given resistance, but the heat increases in a conductor in proportion to the square of the current. That is, if 30 amperes were flowing and it was increased to 60, the heating effect would be four times as great. $30 \times 30 = 900$. $60 \times 60 = 3{,}600$.—R. A. B.

* * *

(a) The line loss is 36,000 watts, which does not include the power furnished to the customers, but is merely that loss in the line transmission which is caused by certain current furnished through a certain resistance. The additional power for the customers would necessarily be furnished at the power house.

(b) The line loss in any transmission line may be reduced by increasing the voltage so that a smaller current is furnished, or by increasing the amount of copper in the line which will, of course, reduce the resistance. The higher voltage is preferable providing the apparatus in the circuit is designed for it; otherwise, the apparatus in the circuit would be burned out. The line loss is dependent upon the current through the conductor and not upon the voltage at the power house or at the customer's end of the circuit.

(c) The current and the resistance are the factors to be considered in heating.—A. C.

* * *

Questions for May

1. *What effect does platinum have used as a "catalyzer" in the manufacture of sulphuric acid for acid batteries?*

2. *Is it a good or bad indication when a thoroughly discharged battery "gases" immediately when put on charge at a normal rate?*

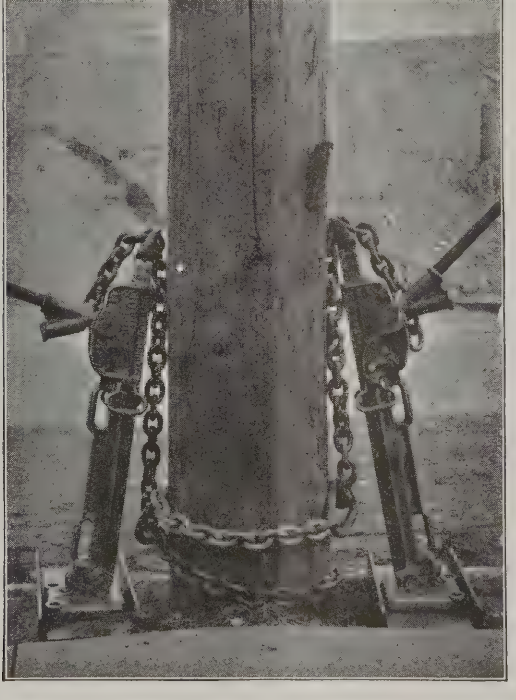
3. *Suppose a 110 volt motor designed for 10 amperes is connected to a 220 volt line with a 10 ohm resistance in series with it. When tested it was found to be getting too much current and it was decided to place a shunt temporarily around the motor to take care of the extra current. What would be the value of the shunt?—R. A. B.*

NEW DEVICES

A Jack for Extracting and Lowering Poles

It is not uncommon in railway service to encounter jobs involving the withdrawing of poles from the ground or their lowering into position. In such cases it is often the practice to perform the work with whatever equipment is at hand. In view of this fact, it is of interest to note a recent development for this purpose.

The Joyce Pole Jack No. 88, as this device is known,



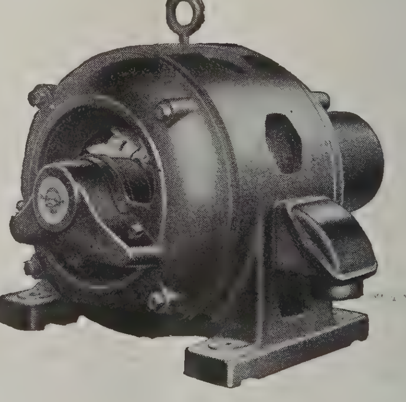
Two Joyce Pole Jacks in Position for Extracting a Loaded Pole

is designed both for pulling and replacing loaded poles. As shown in the illustration, it is built upon a pivoted base and has an unusually long rack which carries a dog at the top to hold the chain. This jack is 38 in. high, has a lift of 27 in., weighs 150 lb. complete with chain and lever, and has a lifting capacity of 15 tons. The mechanism consist of two coils and a large spring, and the construction is such as to afford security against breakage at any point, particularly in the base, which is usually the weakest point of such devices.

The jack is operated by means of a lever as any ordinary jack and is secured against the possibility of dropping the load, the operation of lowering the pole requiring the operator only to reverse the control lever at the side of the jack whereupon the load is lowered automatically one notch at a time, in the same manner as it was raised. The double lever socket shown in the illustration is provided to permit of its easy operation when the jack is pivoted on its base against the pole. Where it is simply required to extract the pole one jack is sufficient, the reason for using the two jacks shown in the illustration arising from the fact that the pole was a loaded one which it was intended to hold in place while the butt end was sawed off. This device is manufactured by the Joyce-Cridland Company, Dayton, Ohio.

"Power-R-full" Polyphase Motors

A line of polyphase motors which embodies a number of new features has recently been placed on the market by the Wagner Electric Manufacturing Company, St. Louis, Mo. Following are some of the improvements which the manufacturers have incorporated in their new line: cool running is effected by



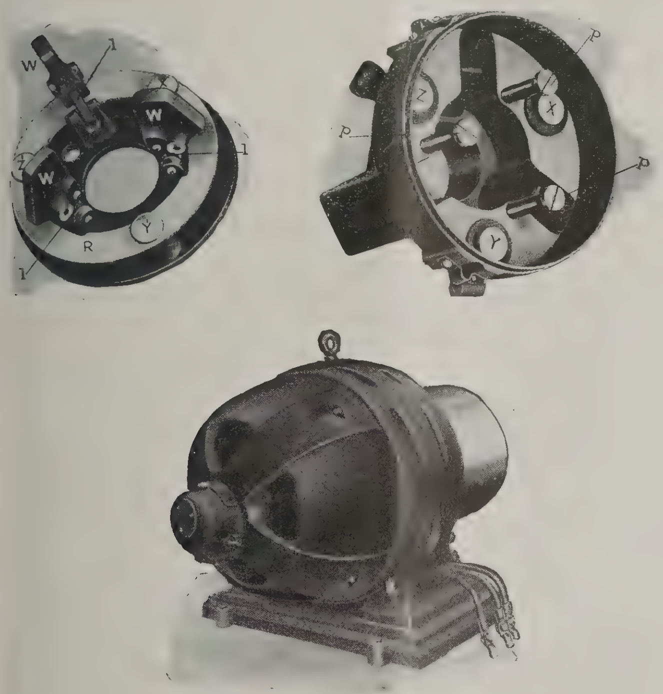
Polyphase Motor Embodying a Number of New Features

directing air through definitely designed ducts in the machine; the coils are wound in phase groups without splicing connections, and impregnated with insulating compound to secure good insulation; generously designed phosphor-bronze bearings, dust-proof housings and current lubrication minimize bearing trouble; a

pull box attached to the motor frame into which the motor leads are brought with suitable terminals for easy connection to external circuits; an unusually large shaft which decreases deflection; noiseless operation by use of the large shafts and bearings, by arranging slots on a spiral, and by clamping the laminations of both stator and rotor under enormous pressure.

Self Starting Induction Motors

A new type of induction motor has recently been brought out by the Triumph Electric Company, Cincinnati, Ohio, which embodies the desirable feature of a high starting torque. This feature has been secured by the rotor windings and centrifugal governor mounted on the rotor shaft. The windings of the rotor are so connected that when the switch is in the starting position, the proper total resistance for starting is set. When the motor reaches a predetermined speed, the centrifugal force of the weights W on the governor overcome the resistance of a spring and the



Motor and Contact Parts

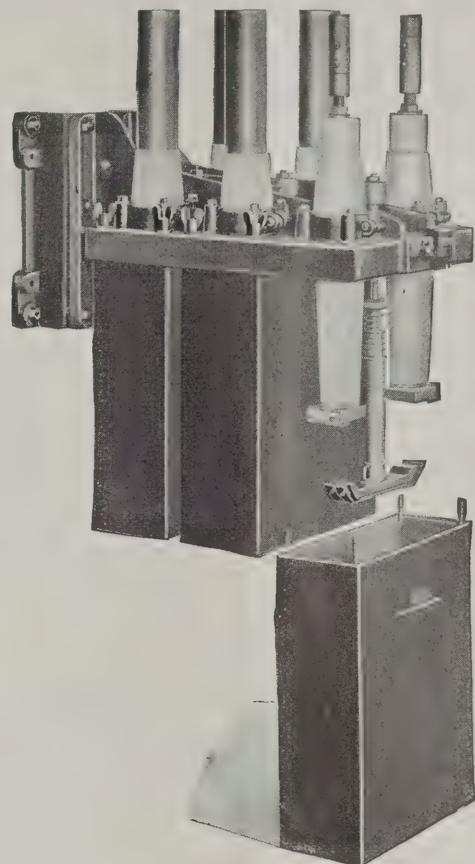
contacts X Y Z are forced against the contacts X' Y' Z', thereby short circuiting their several connections.

The centrifugal governor is securely mounted on the shaft inside the bracket and is therefore entirely automatic and independent of the skill of the operator. The stator crown is of close grained soft iron and is bolted to a cast base. Bearings are of bronze and are provided with pressure release grooves drained to the oil well.

The line of "TR" automatic induction motors, as they are called, covers a range of from 3 to 50 hp. They may be had for operation on 220-volt, 440-volt or 550-volt, 2 or 3 phase, 60-cycle circuits.

A Quick-Break Circuit Breaker

An oil circuit breaker known as type D-22 has been developed by the Condit Electrical Manufacturing Company, Boston, Mass., to meet the demand for a higher interrupting capacity switch of common frame construction. This switch incorporates the principles of the present type D-12 switch manufactured by this company. It is conservatively designed with a rugged frame to insure contact alignment. A separate tank is provided for each pole of the switch and each tank is rigidly supported at four points on the frame. An extended web on the frame re-enforces the upper part of the tank.



Type D-22 Oil Circuit Breaker

Quick break is obtained by the spring action of the laminated contacts assisted by accelerating springs. The standard equipment consists of laminated contacts on all sizes of switches with auxiliary arcing tips for making and breaking the current. High-glazed, wet-process porcelains are used as insulation for the current carrying members. This type of circuit breaker is furnished for either hand or electrical operation in sizes up to and including 1,200 amperes at 15,000 volts.

Calite is the name given to an alloy which has been developed by the Schenectady research laboratory of the General Electric Company. The metal is a development of the process of calorizing which consists of the formation of a surface alloy of aluminum on ferrous and nonferrous metals for the purpose of preventing corrosion. Calite is an alloy of nickel, aluminum and iron. It resists corrosion at high temperatures and is practically unaffected by salt water. It cannot be machined in cast form nor cut with oxy-acetylene.

General News Section

Work on the electrification of the Chilean State Railways between Valparaiso and Santiago was begun on April 12, according to press dispatches from Chile. The Westinghouse Electric & Manufacturing Company has this contract.

A recent report states that the work of electrifying the St. Gotthard Railroad, Switzerland, which connects Switzerland and the north of Italy and the south through the famous Gotthard Tunnel, has been completed. The complete installation was described in the June, 1921, issue of the *Railway Electrical Engineer,* page 221, and additional information concerning the locomotives was published in the February, 1922, issue, page 45.

According to the Charleston Daily Mail there are persistent rumors to the effect that electrification of the Baltimore & Ohio between Grafton, W. Va., and Cumberland, Md., is being contemplated by company officials. The paper states that Daniel Willard, president of the Baltimore & Ohio, spoke recently in Fairmont, W. Va., and says further that while he spoke but briefly on the subject of electrification that since then the talk of electrifying the road has been prevalent.

One of the Airplanes of the post office department was flown from Chicago, Ill., to Washington, D. C., on April 13 in six hours two minutes. The distance is calculated at 715 miles, making the average speed 119 miles an hour. On April 17 a seaplane was flown from Palm Beach, Fla., to New York City, 1,210 miles, in 11 hours 16 minutes, including a stop of one hour 20 minutes. A part of this flight was made in a dense fog in which the aviator was obliged to steer by compass.

The Westinghouse Electric & Manufacturing Company announces the separation of its power and railway divisions with the following new appointments: Barton Stevenson, who has been manager of the power and railway divisions, will continue as manager of the power division and will devote his entire time to activities in connection with that unit. F. G. Hickling has been appointed manager of the railway division, the appointment becoming effective immediately. S. R. Shave has been appointed manager of the price section of both the power and railway divisions in the Pittsburgh office. The separation of the two divisions under different heads will facilitate the handling of both power and railway business.

Wireless Telephones may be used on moving trains and between New York Central boats and shore, according to a statement in the April issue of the New York Central Lines Magazine. Experiments have been going on for some time and there is no longer any doubt but that the wireless telephone can be used for the purposes mentioned; it is simply a question as to whether the cost of installation and maintenance will make the adoption of the new system prohibitive and whether the apparatus can be made rugged enough and simple enough for train service.

The Passenger Traffic Department of the Chicago, Milwaukee & St. Paul Railway announces that the general superintendent of motive power, L. K. Sillcox, has arranged with several of the more important educational institutions of the country for a series of lectures on C., M. & St. P. electrification to be given by technically trained members of his staff. While the lectures primarily are given for the information of students of engineering and the faculty of the various colleges, it is desired in addition that they be attended as far as possible by other persons who are interested in this subject. Schedule for lectures already arranged is shown below.

These lectures are illustrated by lantern slides and over two thousand feet of moving picture film. The time required is about one and one-half hours. It is quite possible that additional dates can be arranged before other organizations in the vicinity of places where the present lectures are scheduled, providing the lecturers can find it convenient to make the dates.

These lectures should be interesting to traffic clubs, chambers of commerce, and similar organizations of business men, and if you have an opportunity to secure dates, please take up at once with George B. Haynes, general passenger agent, who will advise you if it can be arranged.

No charge is made for the lectures, but it will be necessary for the organization to furnish a moving picture machine with operator, also lantern slide projecting machine with the necessary screen.

Schedule of Lectures

Apr. 12	Syracuse, N. Y.	Syracuse Univ.	A. B. Baker
Apr. 12	Blacksburg, Va.	Va. Polytechnic Inst.	J. A. Anderson
Apr. 15	Minneapolis, Minn.	Mpls. Traffic Club	
Apr. 16	Orono, Maine	Univ. of Maine	J. A. Anderson
Apr. 17	Columbus, Ohio	Ohio State Univ.	L. J. Murray
Apr. 19	College Park, Md.	Univ. of Maryland	J. A. Anderson
Apr. 23	Lafayette, Ind.	Purdue Univ.	H. W. Williams
Apr. 24	Lexington, Ky.	University of Ky.	

Railway Electrification in Holland

London.

The proposal to electrify the Dutch railway system is meeting with considerable opposition, according to the Economic Review (London) and M. J. J. W. van Loenen Martinet, who was a member of the commission appointed in July, 1918, to study the question, lecturing before the Dutch Royal Institute of Engineers, argued against immediate electrification of the system as a whole. In countries possessed of ample water power, like Switzerland, Sweden and Austria, which moreover suffered severely from a shortage of coal during the war, it was a reasonable proposition, but not in a flat country like Holland, which had no water power.

The coal consumption of the two Dutch railway companies in 1913 amounted to about 800,000 tons. Had the entire system been electrified there would have been a saving of 40 per cent, as against which there would have been the cost of construction and the purchase of rolling stock, also the cost of central power stations and the loss on scrapped locomotives.

Judged by this data the proposition was an absurd one.

If a careful selection were made of lines to be electrified, there might possibly be a saving of from 50 to 60 per cent on the coal consumption, but even that would not justify the scheme. Only in Germany and in Switzerland were they carrying out a complete electrification of the railway system on a uniform principle, the one-phase alternating current system. After considering the various systems of the different countries, the Dutch Commission had pronounced against the rotary current system as wholly unsuited to Holland. The main question to be considered was the possibility of obtaining from the central power stations a sufficient constant tension, and the likelihood of the high tension system on the railways admitting of a regular supply of electric current. The commission also contemplated the possibility of a portion of the electric plant eventually being manufactured in Holland, but, to begin with, they would require foreign supervision in the starting of their motor industry.

Railway Extension and Electrification in Java

Steady progress is being made on the construction of the railway line between Martapoera and Banjoeberang, Java, according to Commerce Reports. One section of this line was opened to traffic in October, 1921. A new line is projected between Macassar and Boni Plain in Celebes, but this project has not yet taken definite form.

The estimates made in the Netherlands Indian budget for the electrification of the railways of Java have been accepted, but no time has been set for the beginning of the work. A German concern has recently sent a special representative to Java for the purpose of studying the plans and making competitive bids on machinery and supplies.

Helium for Transatlantic Airships

Airship enterprises in the United States and elsewhere are counting on the use of helium gas in future because the helium, unlike hydrogen, is not inflammable. A communication has been received by the American Chamber of Commerce in France from the Adams Aerial Transportation Co., Times Building, New York, expressing a desire to develop relations with aerial organizations in France in the matter of the transatlantic problem. Attention is called to the fact that an aerial transportation company in Barcelona intends to operate lines between Barcelona and South America and to make use of helium.

The New York company referred to hopes to start a line of airship travel between New York City and various cities in the United States, the gas to be employed being that of helium. The plan is to install a large air port near New York, this to be the terminus of lines connecting with American cities farther west. Also, the New York air port would be the terminus for the transatlantic lines.

Copper Cooling Coils for Transformers

In order to protect its customers, the Westinghouse Electric & Manufacturing Company will not furnish any more iron cooling coils with water cooled transformers. Heretofore either copper or iron cooling coils were furnished, the former being somewhat more expensive. In the future copper coils only will be furnished, but at the same price as previously charged for iron.

The decision to furnish copper coils only was made when it was ascertained that a number of customers bought iron cooling coils instead of copper cooling coils to save money. This frequently resulted in trouble for the customers because of the rusting or clogging of the iron cooling coils.

Rock Island to Issue Historical Booklet

The Chicago, Rock Island & Pacific, in connection with the observance of the 70th anniversary of the road, next October, will distribute a booklet giving interesting historical facts regarding the development of the road since the first passenger train was run from Chicago to Joliet, Ill., on October 10, 1852. This was the same year that the first railroad train reached Chicago from the East.

Personals

W. N. Fenley, sales engineer of the Kerite Insulated Wire & Cable Company, with headquarters at Chicago, has been promoted to western manager with the same headquarters, succeeding B. L. Winchell, Jr., who has been appointed vice-president, with headquarters in New York. Mr. Fenley entered railroad service with the Cleveland, Cincinnati, Chicago & St. Louis in 1895, with which company he remained for three years; being yardmaster at Greenburg, Ind., during the latter two. In April, 1898, he entered the service of the National Switch & Signal Company, with which company he was engaged in construction and maintenance work until June, 1900, when he entered the employ of the Chicago Great Western at St. Paul, Minn. During the next 10 years, he was successively foreman, inspector, office engineer, supervisor and signal engineer of that road, having been promoted to the latter position on February 9, 1908. He also acted in the capacity of consulting engineer for the McClintock Signal & Supply Company during 1906 and 1907. He left in 1910 to become sales engineer of the Union Switch & Signal Company, with headquarters at Chicago, which position he held until August, 1911, when resigned to become signal engineer of the Panama Railroad. On September 16, 1913, the telephone, telegraph and signal departments of this company were consolidated, and Mr. Fenley was appointed superintendent of the combined organization. He resigned on June 31, 1915, and was appointed sales agent of the Kerite Insulated Wire & Cable Company, which position he was holding at the time of his recent appointment.


W. N. Fenley

C. E. Skinner, scientist and manager of the research department of the Westinghouse Electric & Manufacturing Company, has been appointed assistant director of

engineering in that company. His duties as assistant director will cover research, standards and other work along these lines. He will be located in the main engineering offices at East Pittsburgh, Pa.

Mr. Skinner is known throughout the electrical world for his extensive research work, especially on insulation. In 1895, he was placed in charge of insulation design in the engineering department, taking charge, in 1902, of the insulation division of this department.

Mr. Skinner has contributed frequently to the literature of the industry, and is well known for his researches abroad as well as in this country. In 1915, he was a special representative of the American Institute of Electrical Engineers, of which he is a fellow, at the international conference on electrical standards held in London, and he is now a member of the committee representing the Institute of the International Electrotechnical Commission. He was chairman of the American delegates to the Brussels meeting in 1920.

Mr. Skinner was born near Redfield, Ohio, on May 30, 1865, and was graduated with the class of 1890 from Ohio State University. In that year he joined the Westinghouse organization in the controller department, and supervised the construction of the first controller turned out by that company. Soon afterward he was placed in charge of the testing of insulation, and in 1892 he was transferred to the research laboratory.

Mr. Skinner is also a member of the Franklin Institute, the American Physical Society and the American Society for Testing Materials. He was a member of the National Research Conference in 1917 and 1918, and also a member of the advisory Council of the Division of Engineering.

George W. Schalchlin, sales engineer for the Allen-Bradley Company, manufacturers of electrical controller devices, Milwaukee, Wis., has been appointed manager of this company's new district office in St. Louis, Mo., effective April 10. Mr. Schalchlin was born at Little Rock, Ark., in 1893, and was graduated from the electrical engineering department of the University of Arkansas in 1913. He served two years' apprenticeship in electrical testing in the factory of the General Electric Company, Schenectady, N. Y. In 1916, he was made manager of the Magnolia plant of the Arkansas Light & Power Company and went from there to the Panama Canal on electrical construction work for one year. During the war Mr. Schalchlin served as first lieutenant Battalion Adjutant 142 Field Artillery in France. On his return from foreign service he entered the employment of the Allen-Bradley Company in Milwaukee as controller engineer, which position he held until placed on the sales force of this company in June, 1921.

G. W. Schalchlin

Trade Publications

Industrial Trucks.—The Eleveyor Electric Industrial Truck Company, 56 Huntington Street, Brooklyn, is distributing two leaflets covering "Eleveyor" electric industrial truck with loading platform.

The Martindale Electric Company, Cleveland, Ohio, has issued a new four-page circular on Commutator Grinding and Slotting, which fully describes their Imperial Commutator Stones and three devices for undercutting mica.

Transformers.—The Moloney Electric Company, St. Louis, has issued catalog No. 215, covering its various types of transformers, including dimensions, price lists, etc. Catalog No. 217 issued by the company contains information in regard to the care and use of different transformers.

Panel Boards.—A 4-page folder issued by the Sprague Electric Works describes a new type of narrow-unit panel board of the safety type manufactured by that company. The board described is a new design 10 inches wide which is equipped with 20-ampere tumbler type switches with moulded bases and barriers.

Lifting Jacks.—The Templeton, Kenly & Co., Ltd., Chicago, has issued a 24-page booklet illustrating and describing its line of Simplex jacks for track and bridge work, car repairing, pulling and straightening poles, etc. Considerable space is also devoted to an explanation of the theory of jack operation.

Controllers for Electric Motors is the title of a small 32-page booklet recently issued by the Electric Power Club of St. Louis., Mo. A simple description of controllers for electric motors, and definitions of the terms used in that connection have been compiled in the handbook. Words which do not appear in the regular dictionary are explained in simple language. Handbooks may be obtained from leading manufacturers or from the Electric Power Club.

Switches and Panel Boards.—Catalog No. 12-A, now being distributed by the Westinghouse Electric & Manufacturing Company, describes safety switches and panel boards. The catalog is profusely illustrated, dimensions and list prices of the various switches are given. The apparatus described includes the railway type of safety panel boards, safety car lighting panels, auto-lock control panels, dead-front and dead-rear safety switchboards, live-front knife switches and many other devices.

Lighting Data.—Nine new bulletins on the general subject of lighting have been issued by the Edison Lamp Works of the General Electric Company, Harrison, N. J. The subjects of the bulletins, with their respective bulletin numbers, are as follows: The Lighting of Public Buildings, L. D. 135; Church Lighting, L. D. 136; Residence Lighting, L. D. 137; The Edison Mazda Lamp for Motion Picture Projection, L. D. 107A; The Eye as Affected by Illumination, L. D. 130; The Lighting of Signs and Billboards, L. D. 131; The Lighting of Large Dry Goods and Department Stores, L. D. 132; Lighting of the Clothing Industry, L. D. 133; The Lighting of Metal Working Plants, L. D. 134. These bulletins are well illustrated with photographs and contain from 16 to 28 pages each.

Railway Electrical Engineer

Volume 13 JUNE, 1922 No. 6

The Convention Reports

There is reason to feel that the approaching semi-annual convention of the Association of Railway Electrical Engineers will be of special importance. It is now two years since the electrical men have had the opportunity of a general meeting and many important developments and changes have taken place in that time.

The committee reports are brief. This was to be expected since they are merely progress reports. In view of the fact that there are so many other things to be accomplished in so short a time, it is well that the reports are brief. It is interesting to note, however, that each one of them indicates progressive thought and investigation, which should lead to some excellent and instructive reports when the fall convention is held next October. The progress reports of the committee on data and information, electric welding, illumination, electric repair shop facilities and equipment, motor specifications, power plants, and power trucks and tractors will be found in this issue of the *Railway Electrical Engineer*.

The reports of two committees; namely, the committee on train lighting equipment and the committee on locomotive headlights, will be published in the July issue. Printed copies of these last two reports will be available at the convention hall and have been mailed to all members of the Association of Railway Electrical Engineers.

In addition to the progress reports mentioned, there will also be presented a paper on electric heating in railroad shops by B. F. Collins, of the General Electric Company.

Nickel Copper Alloys

Nickel-copper alloys are used to a very limited extent by the railroads, but they have great possibilities and will no doubt find a place in railroad practice. Monel metal is probably the best known of these alloys and is remarkable for its great tensile strength and its resistance to corrosion. It is a natural alloy which contains about 65 per cent nickel, a little over 30 per cent copper and, after refining, about 2 per cent iron. It has a tensile strength of about 75,000 lb. per square inch and in general practice is used for making steam turbine blades, valves, valve seats, cutlery, propeller shafts and for many other purposes that call for the use of a metal that will not be corroded by salt water.

In railroad practice it has been used to a limited extent for valves, valve seats and bells, and in foreign countries a number of experiments are being made to determine its suitability for locomotive firebox sheets.

By using nickel-copper welding rods, it is possible to obtain high-strength welds in cast iron without resorting to the use of studs. The alloy has a great affinity for carbon and this is probably the reason it is particularly suitable for the welding of cast iron. If cast iron is welded without studs with ordinary steel electrodes, there is a weak section between the cast iron and the cast steel of the weld. When a nickel-copper welding electrode is used, this is not true. If the amount of welded material to be added is large, the ordinary steel electrode can be used for the greater part of it, the alloy being used to form a layer between the iron and the steel. If the surface is to be machined the alloy can be again used for the last layer of the weld. Information concerning welding with Monel metal appears in an article published elsewhere in this issue.

The Wrong Man Again

It is a mistake for a supervisory officer without a special knowledge of electricity to over-rule the electrical engineer on strictly technical matters. If he cannot trust his electrical engineer on such questions then it is time to make a change and get an electrical engineer that he can trust. For some reason which is difficult to comprehend some supervisory officers appear to harbor the idea that they are just as capable of administering purely electrical affairs as are the men who have devoted their whole lives to electrical work.

Such a case recently came to the attention of the *Railway Electrical Engineer*. A certain mechanical officer was told that it was quite possible to light a number of new coaches which his road had just purchased with fifteen cells of lead storage battery. Although he was strongly advised by his electrical subordinate that the result would be unsatisfactory, the advice was disregarded and the fifteen cell equipments were installed. Of course, the inevitable followed and the passengers complained loudly about the poor lighting. Any electrical man knows that 32-volt lamps will not operate satisfactorily on a battery which, when fully charged, will give but 30 volts. The mechanical officer thought he could save the expense of one cell per car and he did, but at what a cost. When the cars were equipped with 32-volt lamps which were standard for all other cars on the road, the illumination was reduced about 15 per cent and the complaints which arose were so numerous that it became absolutely necessary to install special 30-volt lamps in the cars, thereby adding another line to be carried in the lamp storeroom.

When electrical men are trying in every way possible

to establish standards and reduce specialties, it is discouraging to face such lack of co-operation. It is quite true that one cell of battery was saved per car, but the introduction of a new type of lamp with the resulting confusion of standards is certain to offset any such savings many times over. Further comment seems unnecessary.

The Unkept Promise

A promise is one thing and its fulfillment another. In the purchase of electrical material it is quite as important to know from whom you buy as to know what you buy. It is unfortunately not an uncommon thing to have goods promised for delivery by a certain date and then to have the date pass by without the delivery being made. Perhaps a delay of a day or so would not make so much difference, but where it is prolonged it may easily result in a very real expense. For example, a certain road was in the market for several thousand feet of No. 4 copper wire. One manufacturer offered it at immediate delivery at a price three cents per foot higher than a competing manufacturer who promised it on a 30-day delivery. The natural tendency was to accept the lower price since the need for the wire could be postponed for 30 days. The order was placed with the manufacturer who promised the 30-day delivery. At the end of the month the delivery was postponed. Another month passed and still no delivery was made. Finally, at the end of three months the railroad company was told it could have the wire if it would come after it.

What had happened in the meantime on the railroad? The need for wire had become more and more urgent. Wire was taken from other circuits to supply the more important ones. All sorts of make-shifts had to be resorted to, every one of them expensive. Where was the saving of three cents a foot on the wire? The actual cost to the railroad of that particular transaction was never recorded, but without doubt the expense incurred due to the delayed delivery many times exceeded the saving in first cost.

Letters to the Editor

Operating Figures of the Butte, Anaconda & Pacific

Anaconda, Mont.

To the Editor:

In order to clear up any misunderstanding which may have been created by statements made by Mr. George Gibbs pertaining to electrical equipment operated by the Butte, Anaconda & Pacific Railway Company, and reliably to inform the readers of the *Railway Electrical Engineer,* the writer respectfully urges that the following statements be made:

1.—Flash-overs at the commutators of the traction motors have occurred infrequently due principally to reversing—rough track—or accompanied with the presence of water after having operated over tracks submerged in water. Excepting a few injuries, due to handling, not a single commutator has been turned on account of wear during approximately nine years of continuous service. The commutators show no evidence of arcing or flash-overs.

2.—The dynamotor, which furnishes current for the auxiliary and control equipment, has performed creditably. The control system operates so nearly perfect that to check the contactor sequence is the exception rather than the rule. The control apparatus operates on a potential of 600 volts.

3.—The usual minor failures in apparatus in all parts of the system have been unusually low. Imperfect dedevelopment has not restrained operation even in view of the fact that this is the first 2400 d. c. system adopted for heavy traction in this country.

4.—The contact system has withstood continuous service and has done practically all that any system could do under similar conditions. The temperature ranges from plus 100 degrees F. to minus 35 degrees and sometimes 50 degrees F.; nevertheless the maintenance cost per mile, including bonding, for the past five years, averages $153.76.

5.—The lack of experience in designing heavy traction equipment has contributed very little to either mechanical or electrical failures in the type selected. This fact can be substantiated by referring to the maintenance cost per locomotive mile, even when pro rated to a 100-ton basis, which was 8.41 cents for the year 1920. Previous years have been operated as low as 5.01 cents per engine mile on a 100-ton basis. These figures do not include retirement and depreciation.

Several steam locomotives are operated daily under certain sections of the contact system and to date the corrosion or coating of the trolley wire has not effected our electrical operation.

The records of the Butte, Anaconda & Pacific Railroad for its 120 miles of overhead lines, two substations (7000 kw. total) and 28 80-ton locomotives are given briefly below and railroad men can well appreciate that the "weaknesses peculiar to the system" are inappreciable.

Maintenance Cost Per Year

	1916	1917	1918	1919	1920
Repairs to locos..	$49,811	$55,846	$60,295	$36,748	$46,610
No. loco. miles..	1,013,901	886,110	935.283	566,997	692,804
Cost per mi. cents	4.91	6.30	6.45	6.48	6.73
Substation equip.	3,083.79	2,597.87	2,054.84	1,101.44	245.87
Poles and fixtures	5,111.44	7,525.29	4,523.28	6,111.78	3,363.50
Distribution	9,627.36	12,409.40	12,690.97	15,428.49	13,424.54
Work train*	3,652.16	....	....	....	....
Miscellaneous ...	....	4.00	....	....	3.54
Total last three items	$18,390.96	$19,938.69	$17,214.25	$21,540.27	$16,791.58
Miles route	30	30	30	30	30
Miles track	119	120	120	122	123
Cost per mile...	$154.54	$166.12	$135.11	$176.56	$136.48

*Work train. Years 1917-18-19 and 20 include work train service in accounts "poles and fixtures" and "distribution."

Yours truly,

F. W. Bellinger.

Elec. Supt. Butte, Anaconda & Pacific.

New Books

Economics of Electrical Distribution.—By P. O. Reyneau and H. P. Seelye, first edition, 209 pp., illustrated 9 by 6 in. Bound in cloth. Published by McGraw-Hill Book Co., 370 Seventh Ave., New York City. Price $2.50.

In designing, constructing or operating an electrical distribution system, the object to be sought is to provide all customers with good service at the least possible cost over the system as a whole. This result can be attained only by a careful application of economic principles to all parts of the system. This book defines these principles and indicates methods for their application. Attention is called to the need for economic study in design, the fundamental principles are explained, the usual types of problems are indicated and methods of studying them offered.

Semi-Annual Meeting of the A. R. E. E.

Committees' Reports on Progress to Be Presented and Discussed in Atlantic City on June 19

THE Association of Railway Electrical Engineers will hold its semi-annual convention at Hotel Denis in Atlantic City on June 19. This will be the first official get-together of the electrical men for two years and it is expected that a large representation will be present at the meeting. The program is as follows:

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS

Convention Program

Meeting room, ground floor, Hotel Denis, Monday, June 19, 1922.

Meeting will be called to order promptly at 9:30 A. M.

ORDER OF BUSINESS

Address of President.
Report of Secretary-Treasurer.
Unfinished Business.
New Business.
Progress Report of Committee Train Lighting Equipment and Practice.
Progress Report of Committee on Locomotive Headlights.
Progress Report of Committee on Data and Information.
Progress Report of Committee on Electric Welding.
Progress Report of Committee on Illumination.
Progress Report of Committee on Electric Repair Shop Facilities and Equipment.
Progress Report of Committee on Motor Specifications.
Progress Report of Committee on Power Plants.
Progress Report of Committee on Power Trucks and Tractors.
Paper on Industrial Heating by B. F. Collins.

Progress Report of Committee on Data and Information

Committee:—

E. A. Lundy, Chairman Railway Electrical Engineer; J. P. Puette, Supvr., Elec. Equipment N. Y. C. (Lines West); J. E. Gardner, Electrical Engineer, C., B. & Q. Ry.

TO THE MEMBERS:

YOUR committee on Data and Information, which was discontinued in 1918, on account of the stress of work arising from the world war, has been reappointed. The committee this year has followed along the lines laid down in 1918, and shown in Volume X, of the 1918 proceedings. Even though a number of additions could very properly have been made in the requests for information it was thought best that in view of the present abnormal operating conditions it would be advisable to make the report as brief as possible, covering only those points considered to be of the greatest interest to the association.

The following questionnaire has been mailed to the chief operating officers of every railroad of more than 500 miles.

A number of replies have already been received, and it is very encouraging to note that those responsible for the compilation have done a very thorough job, which in turn indicates that your committee should be able to present a comprehensive report at the annual meeting in October.

Respectfully submitted,
COMMITTEE ON DATA AND INFORMATION.

INFORMATION

REQUESTED BY COMMITTEE ON DATA AND INFORMATION OF THE ASSOCIATION OF RAILWAY ELECRICAL ENGINEERS

J. A. ANDREUCETTI, Sec'y, Room 411, C. & N. W. Ry. Station, Chicago, Ill.
(All data, unless otherwise specified, to be given as of Jan. 1st, 1922)

Date ....Name of Railroad...............

ROLLING EQUIPMENT

1. Car Lighting Data

Total number of passenger cars operated....................
Total number of cars electric lighted, owned by R. R. Co......
Number of cars electric lighted, operated by Railroad Co.......
Total number gas lighted cars ....
Total number oil lighted cars ....
Total number combinations with electric.................
Number of head end generating sets for lighting cars........
Total number cars equipped with storage battery, used in head end trains ....
Axle generator system, number of cars, 60 volts.............
Axle generator system, number of cars, 30 volts.............
Axle generator system, number of cars, 24 volts.............
Straight storage system, number of cars, 60 volts............
Straight storage system, number of cars, 30 volts.............

2. Car Lighting Costs (during 1921)

*Average cost per car per month (all classes electric lighted) chargeable to the account "Lighting Passenger Cars" $.....
*Average cost per car per month (all classes electric lighted) chargeable to the account "Passenger Train Car Repairs" $ ....
Total average cost per car per month on account of being electric lighted $..
Average cost per 1,000 car miles (including all costs) $......

3. Car Lighting Belts

State briefly method of computing belt mileage................
....
....
State type of belt used as standard.........................
State average car lighting belt mileage during 1921 on your road
....

4. Industrial Trucks

State number of trucks in use in the following classes of service (a), baggage handling............(b), freight houses and transfers......................(c), battery and commissary ....(d), electric tractors for hauling freight cars...............(e), shop trucks.............
Total ....

5. Locomotive Headlights

Total number of locomotives ....
Number of locomotives equipped with incandescent headlights ....voltage................size of generator, watts ....
Total cost maintenance per headlight per month, incandescent headlights ....
Note—This information will be made use of by the headlight committees of the A.R.M.M.A. and the A.R.E.E.

SHOP AND STATION EQUIPMENT

6. Standard Voltage, Power and Lighting Service

Standard power voltage A. C......Cycles........D. C.........
Standard lighting voltage A. C.....Cycles........D. C.........

7. Purchased or Generated Power in Shops

Give number of shops and total connected horse power of motors:
(A)..........shops where power is purchased for........ H. P. total connected load.
(B)................shops where power is generated for ....H. P. total connected load.

8. Generators, All Classes of Service

(A) Total K.V.A. capacity, A. C................Number of generators ....
(B) Total K.W. capacity D. C....................Number of generators ....

9. Motors

(A) Total No. D. C....................Total H. P.........
(B) Total No. A. C. Single Phase........Total H. P.........
Total No. A. C. Two Phase..........Total H. P.........
Total No. A. C. Three Phase........Total H. P.........

(C) Sizes D. C.	¾ to 10 H. P. incl...15 to 25 H. P. incl ..	25 to 50 H. P. incl...50 to ..H. P. incl. ..
(D) Sizes A. C. Single Phase..	½ to 10 H. P. incl...15 to 25 H. P. incl ..	25 to 50 H. P. incl...50 to ..H. P. incl. ..
Sizes A. C. Two Phase	½ to 10 H. P. incl...15 to 25 H. P. incl ..	25 to 50 H. P. incl...50 to ..H. P. incl. ..
Sizes A. C. Three Phase	½ to 10 H. P. incl...15 to 25 H. P. incl ..	25 to 50 H. P. incl...50 to ..H. P. incl. ..

10. Electric Welding Outfits

Number of welding sets in use......D. C.........A. C........
Range of ampere capacity ....
Number of Single Operator sets.............Number of Multiple Operator sets ....
....
....
....
Number of Automatic Arcs.................Number of Butt Welding Machines ....
Number of Spot Welding Machines................What ampere rating of set do you recommend for use with one operator................two operators.............three operators ....four operators..............

11. Lifting Magnets

Rated lifting capacity ....
Number of each size ....
Voltage recommended ....volts.....
For what classes of service are you using magnet cranes........
....

Progress Report of Committee on Electric Welding

Committee:—

H. R. Pennington, Chairman, Supvr. Welding & Elec. Equip. C. R. I. & P. R. R.

E. Hagensick, Elec. Union Pacific Ry.

E. S. M. Macnab, Eng. of Elec. Car Ltg., Can. Pac. R. R.

G. T. Goddard, Gen. Elec. Fore. I. C. R. R.

To the Members:

The original plan of the committees outlined by the Board of Directors was to go into the relative actual merits of A.C. and D.C. Welding Rivet Heaters and Safe End Flue Welding and the outlining of a specification for Arc Welding Generator Sets, Accessories, etc. Also specification for Single Operators, Direct Current, Arc Welding Generator Sets. This latter tentative specification follows as our progress report. It is the hope of the committee to complete as much of its work as possible by the annual meeting in October.

Specification for Single Operator, Direct Current Arc Welding Generator Set

(A) Generator

The generator shall be of the direct current, inherently regulating type, designed and equipped with the necessary auxiliaries to facilitate the satisfactory formation, maintenance and manipulation of the welding arc.

(B) Rating

(1) The continuous current rating of the generator set shall be stated when supplying energy continuously to a resistance load equivalent to a 22-volt arc, without any part of the unit exceeding a temperature rise of 50° C. with a maximum ambient of 40° C.

(2) The intermittent current rating of the generator set shall be stated when supplying energy for one hour to a resistance load equivalent to a 22-volt arc, without any part of the unit exceeding a temperature rise of 50° C. with a maximum ambient of 40° C.

Note (a) The operation of arc welding implies an intermittent load on the source of energy. The heating effect of such load on the generator will be determined by the welding duty cycle. To evaluate the above normal rating in terms of a welding load, attention is called to the fact that the continuous rating is approximately equivalent to operating the generator at a voltage of 22 when supplying the specified normal current to a welding arc for periods of 30 minutes after intervals of 20 minutes. This assumes the time required for changing electrodes, etc., of 5 seconds or less, as a negligible factor in the cooling of the unit.

Note (b) As the welding duty cycle will alter with the character of the application, it is suggested that an alternative rating be secured from the manufacturer when the estimated welding duty cycle differs radically from the above "equivalent" duty cycle.

Note (c) A normal current rating of from 150 to 200 amperes will meet the average requirements in many repair and production welding activities. Where it is feasible to maintain a high load factor on heavy parts in a well organized welding shop, an intermittent current rating of approximately 300 amperes is desirable.

(C) Operating Characteristics

(1) The operating characteristics of the generator and auxiliary equipment should facilitate the formation, maintenance and manipulation of a satisfactory welding arc over a current range extending from at least one-half of the intermittent rated current, preferably adjustable in steps no greater than 7½ per cent of the intermittent rated current.

(2) The sustained short circuit current shall not exceed 50 per cent nor shall not be less than 25 per cent of the rated intermittent welding current.

(3) The rate of current growth shall be such as to permit a stable arc to be drawn after electrode has been in contact for no more than ½ second.

Note (a) When welding an average arc, the welding circuit shall have sufficient stability to prevent arc rupture due to momentary fluctuations of arc voltage when holding an average arc, as the result of sudden variation in arc length, caused by convection currents, gas blasts, or irregular metal deposition or electrode manipulation.

Note (b) To prevent excessive arc stability and the resultant hazard of excessive oxidation and insuf-

ficient penetration, the character of the welding circuit shall permit the maintenance of ½ in. arc at the intermittent current rating and fusion no more than three seconds.

(4) The sustained open circuit voltage shall preferably not exceed 75 volts.

(5) The generator shall not lose its excitation nor shall its polarity reverse while maintaining welding arcs over the current operating range of the unit.

(6) It shall be possible to operate two or more units of the same type and manufacture in parallel to supply either a high current metallic electrode arc or carbon electrode arc.

(D) Commutation

The generator unit shall give excellent designed commutator and brush area to insure long life and excellent commutation at all loads. A substantial cover or enclosure shall be provided to protect commutator and brush rigging from mechanical injury.

Your committee invites criticism and discussion, also suggestions of features that might be included with this subject.

Respectfully submitted,
Committee on Electric Welding.

Progress Report of Committee on Motor Specifications

Committee:—

E. Wanamaker, Chairman, Elec. Eng. C. R. I. & P. R. R.

J. E. Gardner, Elec. Eng. C. B. & Q. Ry.

E. W. Jansen, Elec. Eng. I. C. R. R.

E. Marshall, Elec. Eng. Gt. Northern Ry.

To the Members:

Your committee submits the following as a progress report:

Four committee meetings have been held to date with good attendance, at two of which motor manufacturers' representatives were called in to joint session—the Electric Power Club was also ably represented. Excellent progress has been made.

It has been practically agreed that the three prime factors to be considered are: Capacity of the windings, capacity of the bearings, and elimination of oil throwing—also the design of ventilating ducts to prevent stoppage of the passage way in motors in ordinary service. There are several minor items to be included.

It is believed that we are going to be able to make a specification based on performance and maximum allowable temperature rise based on continuous full load run followed immediately by 25% overload run for two hours—such specification guaranteeing the railroads a motor of such design as will insure long life and ability to carry overloads such as are incurred in all ordinary railroad practice as regards stationary motors.

The specification as regards prevention of oil throwing will be easily included, likewise the bearing capacity specification, to guard against the use of bearings of too small capacity. The specification for intermittent rating will be made on a similar basis.

Your committee feels that it will not be necessary to refer to the 40-50° controversy in our specification.

By drawing specification as contemplated we are able to take advantage of the standards and work which has been done by the American Institute of Electrical Engineers and the Electric Power Club.

It is intended to have the tentative specification completed prior to June 26, and it is thought the complete specification will be ready sometime in July.

Respectfully submitted,
Committee on Motor Specifications.

Progress Report of Committee on Illumination

Committee:—

L. S. Billau, Chairman, Assistant Electrical Engineer, B. & O. R. R.; J. L. Minick, Assistant Engineer, Penna. System.

To the Members:

The report of your committee this year will comprise primarily a review of the recent developments in the incandescent lamp and illumination field as applying to the railroad conditions covering the following subjects:

1.—Incandescent lamps for train lighting service.

2.—Developments in incandescent lamp field since 1920.

3.—Digest of industrial lighting codes that have been issued by various states.

4.—Recommended illumination intensities for various kinds of railroad buildings and work.

The progress report of the committee will be confined to the first subject.

Incandescent Lamps for Train Lighting Service

Since the adoption in 1920 of the constant wattage basis for rating of train lighting lamps there have been a number of developments in the lamps for this service, including the introduction of the 15 and 25 watt mazda C lamp, and improvements in efficiencies of many of the other sizes. Following is list of train lighting lamps now commercially available, those listed under the standard schedule covering the lamps more or less in general use and those in the intermediate schedule lamps for which the demand is limited, either due to their use gradually diminishing or new types in which the demand has not as yet been established.

Size in Watts	Rated Initial Lumens	Lumens Per Watt	Bulb
	Standard Schedule		
	30-34 Volt Range		
	Mazda B or Vacuum Lamps		
10	94	9.4	S-17
15	154	10.3	S-17
15	145	9.7	G-18-½
25	255	10.6	S-17
25	245	9.8	G-18-½
50	560	11.2	S-19
50	560	11.2	G-30
	Mazda C or Gas Filled Lamps		
50	740	14.8	PS-20
75	1215	16.2	PS-22
100	1700	17.0	PS-25
	Intermediate Schedule		
	30–34 Volt Range		
	Mazda B or Vacuum Lamps		
10	92	9.2	G–18–½
20	208	10.4	S–17
20	196	9.8	G–18–½
	Mazda C or Gas Filled Lamps		
15	151	10.1	PS–16
25	300	12.0	PS–16
50	640	White Bulb Lamp	PS–20

60–65 Volt Range

	Mazda B of Vacuum Lamps		
15	141	9.4	S–17
15	133	8.9	G–18–½
25	250	10.0	S–17
25	235	9.4	G–18–½
50	515	10.3	S–19
50	535	10.7	G–30
	Mazda C or Gas Filled Lamps		
75	1005	13.4	PS–22
100	1460	14.6	PS–25

It is obvious that both from the point of view of the railroads as well as the lamp manufacturers it is very desirable to reduce the number of kinds of lamps to a minimum consistent with meeting the various demands of train lighting service.

While it is recognized there will always be more or less limited demand for certain types of lamps to meet special requirements on the various railroads, your committee believes that the following sizes and types will meet the general requirements of the train lighting service and that the railroads should confine their demands to these as far as possible:

Size in Watts	Voltage Range	Bulb	Vacuum (B) or Gas Filled (C)
15	30–34	S–17	B
25	30–34	S–17	B
50	30–34	PS–20	C
75	30–34	PS–22	C
100	30–34	PS–25	C

On account of the considerably higher efficiency of the 25 watt, PS-16 mazda C lamp the use of this lamp is recommended wherever the advantages of the increased illumination will warrant the increased expense of the cost of the lamp renewals.

Respectfully submitted,
COMMITTEE ON ILLUMINATION.

Progress Report of Committee on Electric Repair Shop Facilities and Equipment

Committee:—

E. H. Hagensick, Chairman, Elect. Engr., U. P. R. R.; G. W. Bebout, Elect. Engr., Chesapeake & Ohio Ry. Co.; Geo. Dodds, Elect. Engr., Delaware & Hudson Company; J. C. McElree, Elect. Engr., Central of Georgia Ry. Co.; E. S. M. Macnab, Car Ltg. Engr., Canadian Pacific Ry. Co.; Jos. A. Andreucetti, Asst. Elect. Engr., C. & N. W. Ry. Co.

TO THE MEMBERS:

Your Committee submits the following as a progress report.

The entire subject matter has been handled by correspondence thus far, it having been impossible to arrange for a meeting. We were instructed to go into the question of keeping electrical equipment continuously in service giving recommendations in regard thereto, also we were to go into the matter of carrying spare parts.

In regard to the general repair shop lay-out it was the thought of the committee that it would be unnecessary to go further into the subject which was covered in the 1920 report, as each installation, of course, would have to be handled separately and numerous local conditions taken under consideration so that further information in regard to a model shop would be of little value.

Attention is called to the purchase of excess and improper electrical apparatus on some roads on account of the fact that all requisitions for electrical material are not passed on by the electrical department.

The selection of the proper type and size of motors at the time original installation is made as having a bearing on the future maintenance is called attention to; also it is desirable for similar requirements at different locations to utilize motors of the same size, type and speed as by so doing the number of spare motors to protect the service will be a minimum. It was felt that one motor of each size would protect a division or district, the spare motors being carried by the store department at a centrally located point from which they could be quickly secured in time of need.

Periodical inspection should be given all electrical equipment to prevent minor defects becoming serious and putting the equipment out of service. The inspection should be thorough and not just a matter of looking over the equipment without noting the small defects that may be developing. It has been brought out that a considerable number of burn-outs are due to motors being allowed to operate single phase, evidently due to lack of proper inspection of contacts on the compensator type starters.

On account of the fact that motors are frequently moved from one location to another it is often difficult in a few years to positively identify a given motor in so far as purchase date, price, etc., is concerned. With the view of keeping a proper record it is desirable to assign a number to each motor, preferably stenciling the number with a steel stencil into the frame of the motor near the manufacturer's name plate. All information in regard to this motor should then be entered on a suitable record card. Under such an arrangement if the motor is sent to a central shop for repairs and manufacturer's name plate has been lost for any reason, full information concerning the motor is at once obtainable and no unnecessary delay will result in making repairs or securing repair parts.

The foregoing covers in a general way the points which are being given consideration by the committee, but we invite criticism and discussion, also suggestions of features that might be included with this subject.

Respectfully submitted,
COMMITTEE ON ELECTRIC REPAIR
SHOP FACILITIES AND EQUIPMENT.

Progress Report of Committee on Power Plants

Committee:—

Lawrence C. Bowes, Chairman, Inspector Stationary Power Plants, C. R. I. & P. R. R.; C. G. Winslow, Ass't. Elec. Eng. Michigan Central R. R.; T. F. Foltz, Elec. Eng. Washington Terminal R. R.

TO THE MEMBERS:

Your committee on account of the conditions on the railroads due to reduced forces, etc., has not been in position to give this subject very much time, but expects to complete its report for the October meeting.

You will recall that your committee in its last annual

report presented a chart and schedule showing the capacity and distribution of the several facilities and the charges therefor in percentage of total power used for the different types of railway terminals.

It is the intention of the committee to take up in its annual report this year the detail elaboration of its former report and to attempt to establish a standard basis of estimating and calculating the proper distribution and charges of facilities served by railway stationary plants. The most important in this connection is the proper charge for exhaust steam heating. It has been the practice in the past to make all charges against power using facilities and consider the exhaust steam heating strictly as a by-product, for which no charge has been made.

In accordance with good engineering and proper accounting, former practice shows up an unfair charge against the mechanical department facilities.

It is also the intention of the committee to work out units of cost which, while not absolutely accurate, will serve as a guide and will be helpful in standardizing methods of power plant accounting on railway systems.

Respectfully submitted,

COMMITTEE ON POWER PLANTS.

Progress Report of Committee on Power Trucks and Tractors

Committee:

Louis D. Moore, Chairman, Electrical Engineer, Missouri Pacific; J. E. Gardner, Electrical Engineer, C. B. & Q.; C. G. Winslow, Assistant Electrical Engineer, Michigan Central R. R.; James Barnett, Power Plant Inspector, B. & O.; E. Lunn, Chief Electrician, Pullman Co.

TO THE MEMBERS:

Your committee has been working along lines established in last year's report with such additions and changes as expedient. It is recognized that the tractor industry is still in a formative state and that many experiments are being made by users as well as manufacturers with a view of definitely predetermining under what conditions power truck and tractor equipment can be advantageously installed and what particular type would be the most suitable and economical to operate under a given set of conditions. The committee has received excellent cooperation from manufacturers, and owners of fleets show a desire to furnish detailed costs so far as this information is available. It appears that in some cases sufficient consideration is not given to the importance of keeping operating costs, while in others owners frankly admit that their business could not be successfully carried on without tractors, and regardless of cost they must be considered part of the plant equipment. The committee would appreciate receiving information which members of the Association can furnish relative to any phase of the subject and would welcome suggestions at the meeting which will enable it to make a more complete report for submission at the annual meeting. The report will cover the subject of gasoline tractors and their application, as well as electrical tractors and the various uses to which such equipment can be used advantageously. Various types of electric tractors will be described, such as the baggage type, both with straight and drop frame; the low platform type; elevating platform type; tiering or stacking type and crane type. The report will include a table indicating the type of equipment most suitable for various classes of work, from which prospective purchasers should be able to obtain sufficient information to enable them to make a start in the right direction toward the installation of either a single unit or a fleet of power trucks. An outline will be included which owners will be requested to use as a guide in preparing cost information which, if furnished to the committee, will enable it to prepare a progressive report yearly, showing the trend of practice which should be of increasing value to those interested in the truck and tractor phase of the transportation problem.

Respectfully submitted,

COMMITTEE ON POWER TRUCKS AND TRACTORS.

Advantages of Easily-Cleaned Lighting Units

High cost of industrial lighting may be due, not so much to the cost of power or the cost of equipment, as it is to the waste caused by dirty reflectors. The only purpose in buying industrial reflectors at all, aside from protecting the eye from glare, is the expectation of saving a large proportion of the light produced by the bulb, by bending back the upward rays and delivering them between useful angles in the working area. Unless this is accomplished the money spent for the reflector is wasted.

The upward half of the light cannot possibly be saved, however, unless the inside of the reflector is kept in a reflecting condition. Dirty reflectors do not reflect. A ray of light is quite unlike a blast of air or a stream of water that may be deflected by coming in contact with any kind of barrier; and, so far as industrial illumination is concerned, a ray of light to be deflected without absorption or destruction must strike a surface that is clean and sparkling.

Candlepower, height and spacing are three important factors in industrial lighting, but only when the reflectors are kept in a reflecting condition. Furthermore the shape of a reflector is of little importance if its reflecting surface is not clean.

The manufacturers of lamps and reflectors have spared no effort or expense to bring them to the highest possible state of development, and are to be congratulated upon their achievement. The lamps and reflectors are about as good as man knows how to make them, and their success or failure in operation depends entirely upon what the user does, or neglects to do, with them. Putting a clean lamp in a dirty reflector will do very little good. On the other hand, it is hardly possible that anyone would clean and polish a reflector without wiping off the lamp; so, in advocating the cleaning of lighting units the lamp may be ignored. Emphasis should be laid on the fact that the reflector should not only be cleaned, but should be polished.

As it is impossible to prevent the dirt from getting on the reflectors, the method of cleaning is of utmost importance. A natural human tendency is to neglect or avoid any work that is "attended with difficulty or danger" and it follows that making the lamps easy and safe of access is an essential factor in accomplishing the cleaning that is so necessary to their successful operation.

The inefficiency involved in cleaning reflectors by the "climbing process" has long been demonstrated. If con-

sideration is given to what the cleaner has to do to get at the high lamps, it will often be easy to understand why so many reflectors are corroded with dirt and rust, without having performed the work for which they were purchased; a particularly absurd loss.

The use of ladders is usually inconvenient, it may interfere with others working at machines and it is often dangerous. Should the lamp-cleaner be obliged to climb up among moving belts, the cleaning operation becomes particularly hazardous.

Many people feel that lamps should be cleaned from a traveling crane wherever that method is available. If the question of hazard is raised, they reply that there is no hazard, that all their cranes are provided with safety walks, with a railing, and that the lamp-cleaner is as safe on the crane or safer than anywhere else. This doubtless would be perfectly true if the lamp-cleaner could always reach his work conveniently from the safety walk, but frequently he can barely reach the lamp when standing on the bridge and he may crawl up on the trolley, where perhaps he can sit down to his work. Furthermore, there are conditions requiring the use of a ladder on the top of the crane.

In some places the crane operator is required to do all the lamp-cleaning and, for the purpose of preventing any other person from disturbing the crane while he is working on the lamps, he is given positive instructions to pull the operating switch, and lock it open, before leaving the cab. Even though he always obeys this rule, a slight error in locating the crane or trolley under the lamp, may make it necessary for him to either reach out in a dangerous position to get hold of the lamp, or climb back into the cab to shift the position of the crane. In such a case the average man is apt to take a chance, and it is a mistake therefore to overlook this probability.

The responsibility for dirty reflectors rests in many cases upon those who design the installation, rather than upon the maintenance department.

It is difficult to understand why lighting units should be installed where there is no possibility of their receiving the necessary maintenance; and it is not at all surprising that so many reflectors never are cleaned, when the places and manner in which they are installed are considered.

Some are so mounted that it is possible to reach out to replace a dead lamp, but that cleaning the reflector is out of the question.

If the high mounted units, those among belts and those in dangerous and inaccessible places, can be disconnected and lowered with a chain or rope, most of the hazard is eliminated and the cleaning of lamps and reflectors can be done well by almost any grade of help. Belts from line shafts to machines on the floor are usually installed at an angle, and as the lighting unit is lowered, the distance between it and the belt increases. The chain or rope for lowering the lamp may be carried in straight lines through pulleys along the ceiling or truss, thence down the wall and fastened. At any point where there is a possibility of the chain getting in contact with moving belts or machinery, it can be passed through a piece of pipe.

Making the lighting unit easily accessible by means of a lowering device enables the lamp-cleaner to grip the reflector firmly under his arm, and so do a much better job of polishing than where he is obliged to work at arm's length, with uncertain balance, and without being able properly to hold the reflector. The use of a disconnecting device keeps the cleaner away from the electric current.

As there are only two reasons for having industrial illumination at all, to facilitate production, and for safety, it follows that if the lighting equipment does not perform these two functions the investment has failed. Loss of light and destruction of reflectors can be easily prevented and, manifestly, the best results will be obtained where methods are provided that do not inspire negligence.

Reflectors do not have to be dirty just because they happen to hang in dirty places, and making them easy and safe of access eliminates the most common excuse for neglecting the maintenance work. The loss of half of the light produced is the same as paying double for power. There should be as much light as is needed where it is needed and lamps should be installed in such a manner as to make them easy and safe of access, in order that they may have a chance to receive the simple attention that is absolutely necessary.

Gasoline Motor Car on Lewisburg, Milton & Watsontown

Swedish Diesel-Electric Motor Car of 250 Horsepower

Diesel-Electric Motor Cars for Railway Service

Successful Operation in Sweden Has Led to the Introduction of 250-Horsepower Cars

SWEDEN is one of the countries which is obliged to import its supply of locomotive fuel and consequently the greatly increasing cost of coal is a serious factor in operating expenses. An abundance of water power has made electrification practical on a number of lines where the traffic is heavy but this change is not feasible on a large amount of mileage where the traffic is relatively light. Both improvements in steam locomotives and the substitution of other sources of power are receiving thoughtful attention. Considerable pioneer work in the application of Diesel engines for railroad motive power has already been carried on in Sweden. The system favored uses a Diesel engine to drive an electric generator which furnishes power to motors mounted on the trucks. The first car, built in 1913, had a 75-hp. engine. This was followed by several other cars with the same size engine and later by others of 120 hp. These cars were built and equipped by the Swedish General Electric Company and the Atlas Diesel Company working in conjunction.

These early motor cars proved to be so satisfactory in operation that a separate company, the Diesel-Electric Car Company, Vasteras, Sweden, was organized to carry on further development work. The new company has turned out several cars of the smaller sizes and in addition built cars of 160 hp. and 250 hp. which are now in regular service. At the present time 12 Diesel-electric motor cars are in service on seven Swedish railroads. That none of the cars delivered has been taken out of service, except when impossible to obtain oil during the war, and that all orders recently received have been from roads that already had at least one car in operation is indicative of the success of the general design.

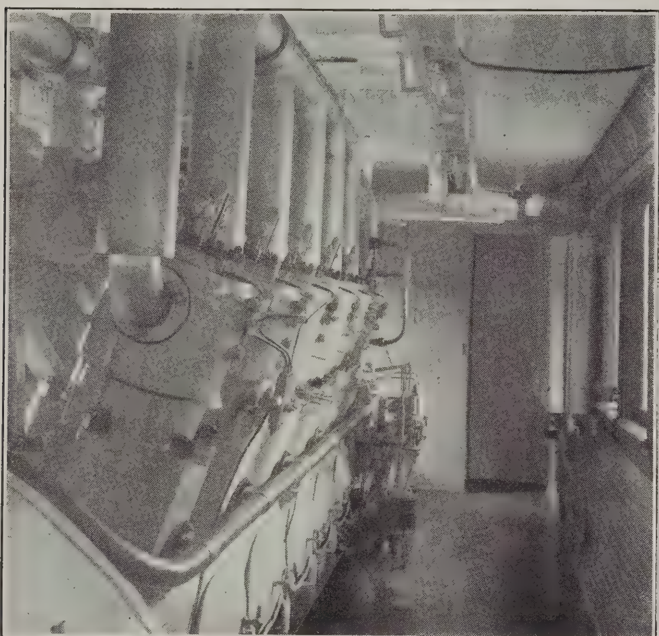
The cars with 75-hp. or 120-hp. engines were provided with compartments having seating capacity for a number of passengers or with space for baggage and mail. One or more small trailers were commonly hauled. The larger capacity cars lately built are not provided with accommodations for passengers but compartments for baggage and mail have been retained, passengers being accommodated in regular coaches hauled by the motor car.

Cars of 160 hp. weigh 37,500 kg. (82,500 lb.) and, when grades do not exceed one per cent, are capable of hauling a trailing load of 67½ metric tons (74¼ short tons) at ordinary speeds. This is a total train weight of 105 metric tons (115½ short tons). Cars of 250 hp. weigh 50,000 kg. (100,000 lb.) and under the same conditions can haul a trailing load of 115 metric tons (126½ short tons) which corresponds to a train of 165 metric tons (181½ short tons) including the motor car. Plain trucks are used on the engine compartment end of these cars and motor trucks, one motor for each axle, under the other end. The cars can be operated equally well from either end. With the passenger cars used in Sweden, which are much lighter than are customary on American roads, the 160-hp. car can haul a train with about 225 passengers while the 250-hp. car can haul a train holding 375 passengers.

When hauling full trains the fuel oil consumption for the 160-hp. engine should average about 0.7 kg. per train kilometer or 2.5 lb. per train mile, while the consumption for the 250-hp. engine should average about 1.0 kg. per

train kilometer or 3.5 lb. per train mile. Oil records of a 160-hp. motor car for an extended period in regular service handling a train of 90 metric tons (99 short tons) showed a fuel oil consumption of about 0.5 kg. per kilometer or 1.8 lb. per train mile. By weight, the fuel oil consumption of the Diesel engines averages about six per cent of that of the coal used by steam locomotives of the same power.

The 160-hp. engine has eight cylinders and the 250-hp. twelve cylinders but otherwise they are similar in general design to the smaller engines. A number of improvements have, however, been introduced in the later designs of motor cars. The cooling water for the Diesel engines is now re-cooled in a number of radiators similar to those used for gasoline motor trucks, mounted on the roof of the car as shown in one of the illustrations. Cooling is effected by means of a fan-blower driven directly from the



Engine Room of 250-Horsepower Diesel-Electric Motor Car

main engine and is thus independent of speed. The motors are now arranged to be connected either in series or in parallel.

In addition to low fuel costs, one-man operation and little time or attention required at terminals, experience has shown that Diesel-electric motors cars can make a greater mileage per day, spend less time in the shop and run for much longer periods without a general overhauling than steam locomotives. They are capable of making 50,000 to 60,000 miles per annum. Even after being taken in for overhauling after some 60,000 miles it has been found that the largest item of expense is for dismantling and reassembling.

While the Diesel motorcar or locomotive will undoubtedly be still farther perfected and adapted to a wider railroad field of usefulness, indications point to a much more general employment of this general type of motor in the near future.

Don't be too blamed positive with your assertions. The other fellow may be right occasionally and of course accidentally.

Power Resources of the United States

The United States is literally the most powerful country in the world, according to a statement made by Dr. Thomas T. Read, of the Federal Bureau of Mines, before the School of Foreign Service of Georgetown University.

"The real basis of power of a nation is its energy resources, rather than its man-power strength," said Dr. Read. "The modern way to use the energy of a man is to employ it in a way similar to the little detonator of the big explosive shell; the little charge sets off the big one and does an amount of work far in excess of its own capacity. The energy output of an average workman is about a tenth of a horsepower. The energy expended by a coal miner in an 8-hour day thus amounts to about that available from 2 pounds of coal. A Japanese miner who gets out 1,400 pounds of coal a day thus multiplies his energy by 700. It is somewhat like planting one grain of wheat and having 700 grow from it. The American miner gets out 8,800 pounds of coal in a day and so multiplies his energy by 4,400. There are 41 million wage earners in the United States and their energy output is a little over 4 million horsepower, or only 9 times the potential energy output in the form of coal, of 100 miners. The power minerals, coal, petroleum, and waterpower are, therefore, the real sources of strength in an industrial civilization.

"Just where the United States stands on this basis is best brought out by some comparative figures which may be stated in millions of horsepower years, so that the figures will be easier to handle. Taking the estimates of probable and possible available coal, petroleum and waterpower in the principal countries of the world and reckoning them in terms of millions of horsepower years, they line up something like this:

Country	Coal (Millions of Hp. yrs.)	Petroleum (Millions of Hp. yrs.)	Energy Resources Waterpower (Millions of Hp.)
United States	500,000	400	37
China	200,000	60	20
Germany	48,000	2	2½
Canada	40,000	40	22½
Great Britain	27,000	(?)	1
Australasia	19,000	(?)	4
Russia	17,000	280	16
Poland and Czechoslovakia	14,000	45	1
India	11,000	70	27

"No other country has as much as one-fiftieth part of the total energy resoucres of the United States, and it is quite evident that many parts of the globe never can support an industrial civilization of any magnitude, for they simply have not the resources of energy."

"Countries differ greatly in the degree to which they have developed their resources. The United States had resources before 1492 even greater than now because they were all unused. China is in somewhat the same position today as the United States was 400 years ago. Japan, on the other hand, is an example of a country that has developed its very limited resources to a large extent. Japan's energy resources are less than one five-hundredth part of those of the United States and therefore the Japanese cannot afford to use their energy for rough uses that require large quantities such as in breaking stone. Weaving silk or decorating porcelain requires but little energy in proportion to the selling value of the finished product, and the natural development of the Japanese people will be toward industries that require a high degree of skill and relatively little energy."

Metallic Deoxidizers in Welding with Monel Metal*

Sound, Strong and Moderately Ductile Welds Can Be Readily Obtained by the Application of Proper Methods

THE welding of Monel metal by the oxy-acetylene torch has never presented any particular or unusual difficulties, such, for example, as would not be presented by steel under the same circumstances. Rods, sheet and castings of Monel metal are regularly welded by this method and sound, strong and moderately ductile welds obtained. Although the practice in such welding is not essentially different from that used with steel, detailed instructions are issued by the International Nickel Company, producers of this alloy, for the oxy-acetylene welding of Monel metal in all forms.

Attempts to arc-weld this metal have hitherto not proven similarly successful, whether by the carbon or the metallic arc method. In such trials the general experience has been that it is difficult to produce consistently, welds which are sound and free from blow-holes, ductile and free from shrinkage cracks.

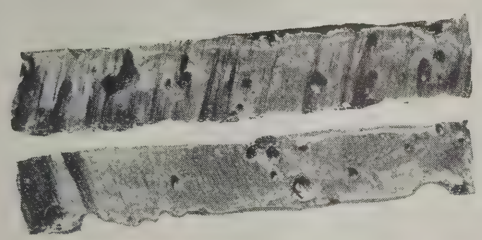


Fig. 1—Photograph Showing Section Through Arc Weld Using Plain Monel Wire Electrode Without Deoxidizer Coating. Numerous Blowholes Present

Inasmuch as the arc-welding method offers in many cases the advantage over the oxy-acetylene one of lower cost, the research department of the International Nickel Company has for the past six or eight months been engaged in an effort to develop satisfactory arc-welding practice for the metal. The particular objective sought was to develop a method of producing sound and ductile welds, free from cracks.

The Welding Properties of Monel Metal

It is now generally recognized among those expert in welding that the behavior of a metal in the foundry; i. e., in being melted, poured and cast in a chill or sand mold throws light on its behavior during welding as, of course, would be expected. A weld is but a chill casting frozen to its mold. This viewpoint has proved particuarly useful in the case of Monel metal.

When this metal (in its virgin form free from manganese) is melted and brought to the correct "pitch"; i. e., such that it has the right carbon content, which varies according to the use from 0.10 to 0.30 per cent, a casting poured from it either in a chill or in a sand mold will in general neither be malleable, ductile nor free from blow-holes. The addition of ferro-manganese or metallic manganese together with about 0.1 per cent of metallic magnesium will, however, "deoxidize" the molten metal and a casting or chill bar or ingot poured subsequently will be both sound and ductile.

It seemed apparent from consideration of the first difficulties encountered in arc-welding that the metal melted by the arc absorbed sufficient oxygen from the surrounding air that it required re-deoxidation in order to make it again malleable and sound. It may be observed that special deoxidation is not necessary in oxy-acetylene welding because the operator uses a reducing flame which protects the hot and molten metal from the air.

This view has been confirmed by subsequent tests and we have definitely ascertained that just as Monel metal must be "deoxidized" before casting into sand molds and ingots so must it be also "deoxidized" in producing satisfactory arc-welds. And the agents which are found to be superior for this purpose are the same as those used in the foundry; viz., magnesium, manganese and silicon, in the order of their importance for this operation.

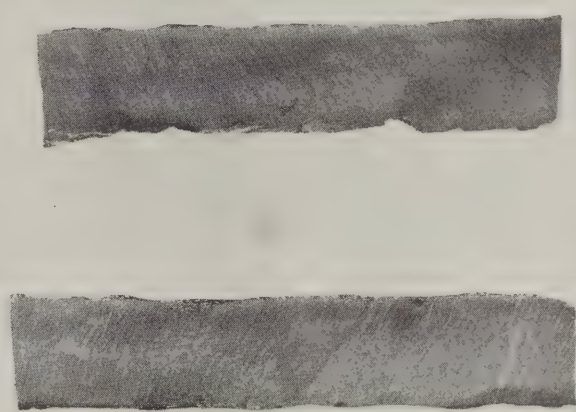


Fig. 2—Photograph Showing Section of Arc Welds Using Monel Wire with Deoxidizer Coating. Absence of Blow-holes Should Be Noted

Deoxidation During Welding

We have found that these agents are best employed in the form of alloys, ground to from 50 to 100 mesh and applied to the welding rod of bare Monel wire as a thin coating. It is obvious that the alloys used for this purpose must be sufficiently brittle and preferably, also, soft, that they can be powdered. The binder which we have found entirely successful is very simply made of denatured alcohol containing ½ lb. to the gallon of shellac. Other similar binders would undoubtedly serve equally well.

According to our experience the exact composition of

*From a paper presented before the Metropolitan Section of the American Welding Society by P. D. Merica and J. G. Schoener, and published in May, 1922, issue of the Journal of the American Welding Society.

this coating powder may vary within moderately wide limits, the essential thing being to introduce into the welded metal about the amounts of manganese and silicon and particularly of magnesium which are generally used for deoxidation in the foundry. Thus we should introduce from 0.05 to 0.50 per cent of magnesium, from 0.20 to 1.00 per cent silicon and at least 0.20 per cent of manganese; the upper limit of manganese is not important, as an excess is not harmful. An excess of magnesium or silicon, however, will tend to produce dirty or brittle metal respectively.

Preparation and Composition of Coating Powder

We have applied these coatings dry simply by making a suspension of the powder in the dilute shellac solution and dipping the wire into it and allowing it to dry. The coating can also be applied by brush, although at greater expense of time and with greater loss of material. This coating we have found adheres well and will not be removed by packing and transportation. It will vary in thickness, but on a 5/32 in. wire will run about a pound to 600 feet and approximately 2 per cent by weight of the wire.

The alloys to be used in the preparation of the powder may vary widely when consistent only with the condition

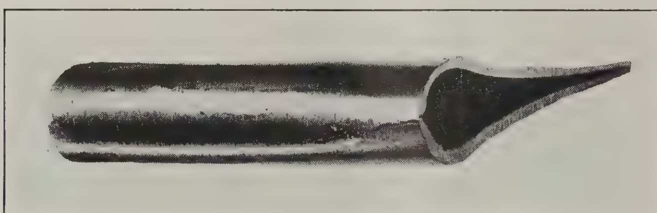


Fig. 3—Photograph Showing Bend in ⅛ in. Arc-Welded Monel Sheets. By Way of Test This Weld Was Purposely Bent Until It Just Cracked.

that all must be powdered and that certain limits noted above as to magnesium and silicon content always be maintained. We have had entire success using ferro-manganese or metallic manganese and one of the silicon-manganese-magnesium alloys produced by the Electro Metallurgical Company and having the following composition as described in their recent booklet:

	Grade No. 1 per cent	Grade No. 2 per cent	Grade No. 3 per cent
Magnesium	25 to 30	14 to 16	8 to 10
Manganese	20 to 25	27 to 33	45 to 50
Silicon	35 to 40	45 to 50	40 to 45
Carbon	Max. 0.20	Max. 0.20	Max. 0.20

Any of these alloys can be used alone or in conjunction with from 1 to 2 parts of ferro-manganese. Of course other alloys or combinations can be used to give similar results. We have used the manganese-magnesium-silicon alloys No. 1 and No. 2 alone and in conjunction with equal parts of ferro-manganese and have not been able to observe much difference between the results with the different composition.

Ferro-manganese alone or with ¼ of a part of ferro-silicon gives good welds at times, but they are not as consistently sound and ductile as with the simultaneous use of some magnesium. The latter seems to be the essential part of the coating, and although the manganese and silicon aid in deoxidation and in producing proper fluidity of the molten metal,—and consequently a good weld surface,—they serve perhaps also in large part as a diluting carrier for the magnesium. The latter cannot be ground and is also too reactive to be used in the pure form as it oxidizes before it ever gets into the weld. The manganese and silicon act to protect it until it is absorbed in the molten weld. A nickel-magnesium, nickel-copper-magnesium or nickel-silicon-magnesium alloy of similar type could be used as well for magnesium carriers, as they are also brittle.

Some Tests of Arc-Welds

To illustrate the results we have obtained with the use of the type-deoxidizer described above, the photographs shown in Figs. 1 to 6 are presented. Particular

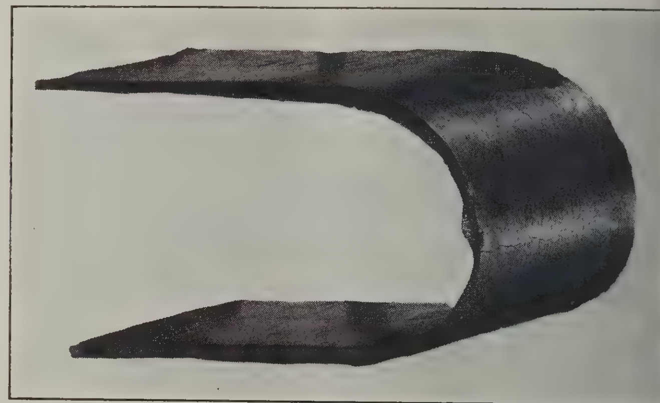


Fig. 4—Photograph Showing Bend in ¼ in. Arc-Welded Monel Plate

attention is drawn to photograph No. 1, which shows the blow-holes generally encountered when welding even with the greatest care, but using bare or other wire without the deoxidizer coating. This should be compared with No. 2 in which a section is shown welded with the deoxidizer coating.

These welds are sound and practically as ductile as are

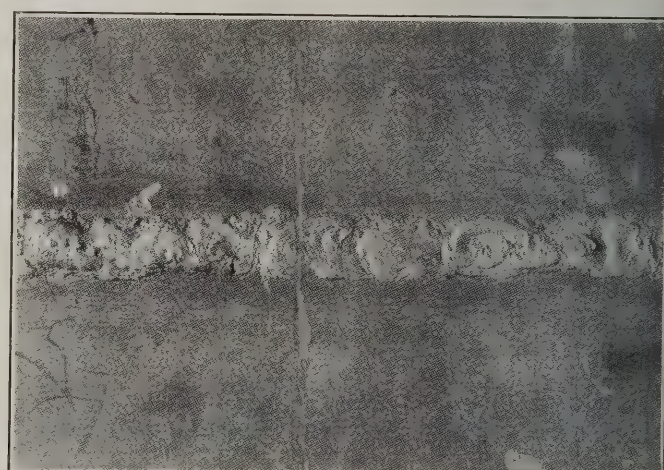


Fig. 5—Photograph of Upper Surface of Arc Weld

welds on ordinary low-carbon steel. The photographs show cold bends of from 30 to 45 degrees in ¼ in. Monel plate.

Tensile tests carried out on 2 in. and 3 in. wide arc-welded strips of Monel plate gave the following results, with which weld tests on the same material with the oxy-acetylene torch are given for comparison.

TENSILE TESTS OF ARC-WELDED AND OXY-ACETYLENE WELDED 3-INCH WIDE STRIP OF MONEL PLATE

Size Arc-welds, in.	Tensile Strength, pounds per square inch	Elongation in 2 in.	Fracture
.250x3	23,300	...	Ragged—two blowholes
.255x3	39,200	...	Ragged—no blowholes
.260x3	44,400	...	Ragged—one blowhole
.245x3	47,800	...	Ragged—four blowholes
.250x2	37,400	8.0	Irregular, slightly oxidized
.250x2	50,200	10.5	Ragged
.250x2	44,200	5.5	Ragged
.250x2	55,500	11.0	Irregular shear
.250x2	65,000	12.5	Ragged shear
.250x2	60,500	9.5	Ragged
.250x2	48,800	8.0	Ragged
.250x2	49,200	12.0	Sq. break
Average	47,100	9.70	
Oxy-acetylene welds, in.			
.250x3	44,600	10.5	Sq. tensile—two blowholes
.240x3	35,100	...	Sq. tensile ragged—3 blow holes.
.235x3	45,500	8.0	Sq. tensile—one blowhole
.230x3	50,500	9.5	Sq. tensile—3 blowholes
Average	43,900	9.3	

Special Features of Arc-Welding Monel

Aside from the use of the special deoxidizer described above, arc-welding with Monel metal is not essentially different in detail from that with steel.

With work ¼ in. thick and over, a 5/32-in. welding wire of Monel, for work from ⅛ to ¼ in., one of from 3/32 to ⅛ in. should be used, the best currents being 180-200 and 75-125 amperes respectively.

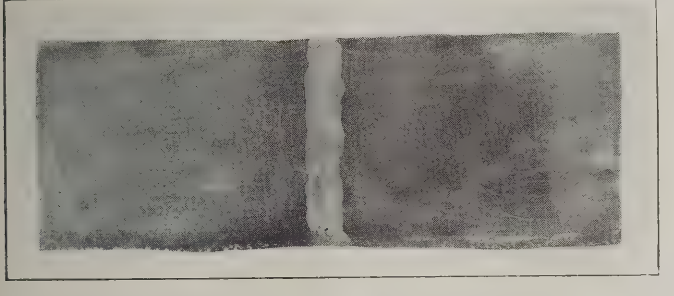


Fig. 6—Photograph of Top Surface of Arc Weld After Burr Has Been Ground Flush and Whole Surface Buffed and Etched

It is best to make the whole weld at one operation and not to build it up in successive layers, as the latter method will likely give cracks and unsoundness. The weld should be well built up above the surface, as there are almost invariably small pinholes just under the surface of the weld, even with best welding practice.

An important variation from usual practice with steel is that of making the welding rod positive instead of the work. When the latter is made positive the metal tends to drop from the electrode and does not flow freely and continuously.

In welding sheet, the usual angle should be left for shrinkage amounting to approximately ⅛ in. per linear foot of weld.

The plate, rod or casting should be well cleaned of all scale by grinding or machining on both sides of the weld edge and it is well to coat these edges, by the use of a brush, with the same deoxidizer as is used on the rod.

The last few years have witnessed an increasing exploitation of tungsten ores in Kiangsi, China. The annual yield has reached over a thousand tons of a value of from 400,000 to 500,000 dollars. Tin is also receiving much attention in the province. The annual output is estimated at about 100 tons of a value of 100,000 dollars.

Schweyer Automatic Train Control

The Schweyer automatic train control system is of the intermittent, non-contact, inert roadside element type of control with no physical contact made between the roadside apparatus and that installed on the engine. The device is used in connection with roadside signals and makes use of both alternating and direct current. The operation of this system is based on the principle of introducing a mass of iron in the path of the magnetic circuit of a coil which is energized with alternating current and which is suspended from the engine.

Since the track armature does not move the train would stop every time it passed the testing point if there was not some means of keeping it running when the signal indicated proceed or caution. This is true, but part of the engine or train is insulated and one side of a polarized relay is connected to the ground of the engine or train and the other side to the insulated wheel or truck so that it picks up current furnished by a local track battery every time it runs through the insulated section under clear or caution conditions.

The Types of Control Employed

Two types of apparatus are shown in Figs. 1 and 2, either of which may be used on steam roads, although electric lines may use only one type. For both types there is a fixed bar "13" having inclined ends alongside the rail. This projects 2¼ in. above the top of the rail, the level section being 2 ft. 6 in. long, and containing

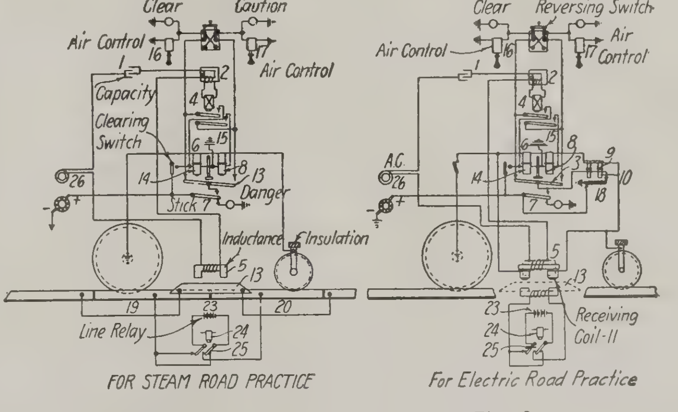


Fig. 1 Fig. 2

Wiring Diagram for the Apparatus

enough metal to properly perform its function as a track armature, as described later. This bar is insulated from the ties on which it is supported and is included electrically in the main track circuit as shown, but has no mechanical connections. In order to handle traffic in both directions these armatures are arranged in pairs on both sides of the track. In one type of roadside apparatus (Fig. 2) a coil is placed in a certain definite relation to the track armature 13 and in such a position that any magnetic field formed by a circuit through it will influence a receiving coil carried by the locomotive. The track coil may be energized from a roadside battery 23, controlled by the usual track relay 24. By means of circuit closers 25 controlled by the roadside signal the direction of current flow through the track coil may be changed.

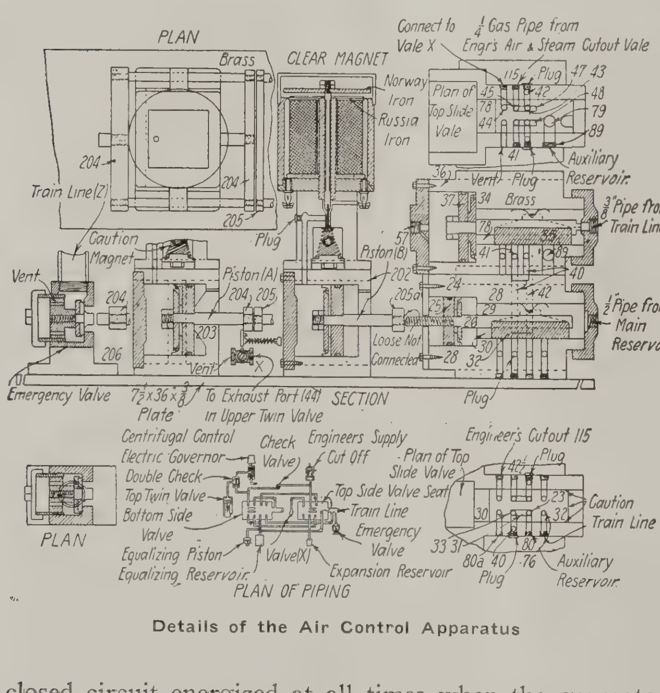
In the other type of control, shown in Fig. 1, two short

track circuit sections 19 and 20 are introduced at each location of the track armature 13. A resistance is introduced around the insulated joint separating the two short sections on one rail, while around the joint in the other rail there is a loop containing the battery for both track sections, which is controlled by pole changers operated by a polarized relay 24; the loop circuit may also pass through the front contact of a relay, or through a resistance if this relay is de-energized. Both of the relays in the loop are controlled from adjacent blocks and depending on the direction of current flow through the loop, as governed by the pole changers, a caution or clear indication is given to a passing train.

The choke coil 5 is installed in such a position as to come within range of the track armatures 13, but it is high enough so as not to be influenced by the rails of a turnout or other pieces of steel that may be part of the roadway structures. When the short track sections are used instead of the track magnet, a portion of the engine is insulated, and a polarized relay and the engine receiving coils are eliminated. The impulse is then received through the wheels and axles when the engine passes over the looped insulated joints.

A Description of the Circuits

Referring to Figs. 1 and 2, turbine 26 furnishes alternating current to the main engine circuit through condenser 1, primary of transformer 2, and around the choke coil 5 back of the collector ring of the turbine and is a



Details of the Air Control Apparatus

closed circuit energized at all times when the generator is running. Another part of the circuit is from the secondary of the transformer 2 through the coils of the main engine a.c. relay 4, which is also constantly energized. The remaining circuits are direct current from the generator grounded on one side. The "clear" circuit goes from ground through one set of electro-pneumatic coils 16; through the left side of the polarized armature 3 in its closed position; and through the stick neutral armature 7 in its raised position back to the generator. The "caution" circuit is from ground through the coils 14 of caution electro-pneumatic valve 17; through right side of polarized armature 3 in its closed position, and through the stick neutral armature 7 in its raised position back to the generator. The upper and lower armatures of the main engine a.c. relay 4 control the stick circuits respectively of "clear" coil 14 and "caution" coil 8. A primary closed pick-up circuit is through the engine receiving coils 11, through the upper coils of a polarized relay 6 and through the time limit relay 9; this circuit, though closed, is normally de-energized and only receives current momentarily when the engine coils 11 pass over track coils. If the track circuit loop is used instead of the track coils, this circuit is connected to the separate insulated parts of the engine.

Depending upon the polarity of the pickup current the effect of the opening of the main engine relay 4 is bridged over when it engages a track armature; if a "danger" condition exists, however, the "clear" and "caution" circuits are not completed since the track coil or the insulated sections 19-20 will not be energized, and the falling of the armatures of the main engine a.c. relay 4 will open the controlling stick circuits, thus producing a stop, and energizing a red lamp through a back contact on the stick armature 7. The other two signals are in parallel with the "clear" and "caution" valves 16-17.

The polarized relay 6 has its coils 14 and 8 wound in opposite directions to each other and each is grounded through ground 15. The current flowing through either 8 or 14 to ground maintains the definite polarity of the polarized armature 3.

The Time Limit Relay

The time limit relay 9, Fig. 2, has its stick armature 18 raised through its upper coils every time the pickup circuit is energized. The wire wound around the armature 18 causes a thermos expansion breaking the circuit at 10 after a certain period of time has elapsed. Any other suitable time limit devices may be used.

The operation of this device is as follows: When the engine choke coil 5 comes within the range of a track armature 13, the current flow through the coil and through the primary of the transformer is greatly retarded. This results in a corresponding decrease in the secondary of the transformer 2, so that the main engine a.c. relay 4 does not receive enough current to hold up its armature, which, therefore, drops. If, now, the block ahead is occupied, all the engine circuits are opened by the de-energization of the main engine relay 4 and the electro-pneumatic valve magnets 16-17 will be de-energized, shutting off the air supply from the two pistons of the air control apparatus, which will permit them to be moved to the left by the pressure constantly exerted on the third smaller piston, thus venting the train line.

If the track conditions are such that a "caution" indication should be received, the main engine relay is opened in the same way, but through the track magnet or short track section a current is picked up, which, by means of the polarized engine relay 6, reverses its polarity, opening the front contact of the armature to the left and closing it at the right. The clear electro-pneumatic valve 16 being thus de-energized, air is drawn off from the longer of the two cylinders, causing the slide valve to move to the caution position, venting the train pipe if the train is running in excess of a speed determined by the centrifugal governor.

If the block is clear, the polarized current picked up

from the track holds the polarized armature 3 in the "clear" or left-closed position, while the main relay a.c. circuit is opened, and there will be no brake application.

The Air Control Apparatus

The operation of the air control apparatus, shown in the illustration, is controlled through the electric circuits that operate electro-pneumatic pin valves 200 and (201 not shown), which, when energized, admit air from the main reservoir to separate cylinders 202 and 203. These cylinders are of the same diameter, but 202 is approximately twice the length of 203. These pistons are connected to yokes 204 and 205 in a manner that allows for the difference in stroke of the pistons. The yoke 205a connects to the piston rod B of the longer cylinder 202 and loosely butts against the rear end of piston rod 26 operating piston 25 in the lower twin cylinder 24 of the same stroke, but of smaller diameter. The main reservoir pressure behind piston 25 tends to pull slide valve 32 to the left when air is exhausted from behind the pistons in cylinders 202 and 203, opening the emergency valve 206 and venting the train pipe.

If, however, the clear position magnet is de-energized and the caution position magnet is energized, the slide valve 32 will only move one-half the stroke to the left, allowing pressure from the supplementary reservoir to reach the bottom of slide valve 35 in the upper twin cylinder 36 by way of pipe 80, port 23, cavity 31 in slide valve 32, port 33 and by-pass 40. If the train is now exceeding a caution or predetermined speed, main reservoir pressure is fed in through port 57 behind piston 37, forcing it to the right against the train line pressure in cavity 78, taking with it slide valve 35 connecting by-pass 40 and port 41 to the expansion reservoir 90. This allows pressure in the supplementary reservoir 86 to reduce, depending on the capacity of the expansion reservoir 90, which causes equalizing piston 84 to raise from its seat and gradually vent the train pipe to the atmosphere through port 96, thus making a gradual application of the brakes. Simultaneously with this action the main reservoir, by way of port 42½, cavity 31a in slide valve 32, by-pass 42, cavity 47 in slide valve 35 and ports 45 and 115, has forced its pressure to the air and steam cut-off valves, cutting off communication between the main reservoir supply pipe and engineman's brake valve and cutting off the motive power. Thus the engineman cannot release the brakes while they are being automatically applied. When the train comes within safety speed the governor causes the main reservoir pressure to be exhausted from behind piston 37, whereby the train line pressure forces slide valve 35 to the left, venting expansion reservoir to the atmosphere via cavity 48, recharging the supplementary reservoir 86 with train line pressure by way of port 79, seating equalizing piston 84 and opening engineman's cutout valves by connecting ports 44 and 45 with cavity 47. Since valve X is connected to port 44 these last two cutout valves cannot be opened except in the clear position as shown.

Assume a train passing a clear signal to be running in excess of caution speed. Slide valve 32 would move to the right, connecting train line pressure to supplementary reservoir 86 by way of port 76, cavity 31, port 31 and port 80. The engineman's cutout valve and motive power cutoff valve would be opened by pressure venting to the atmosphere by way of port 115, port 45, cavity 47, port 43, by-pass 42, cavity 31a to atmosphere, allowing the engineman to have full control of the train.

If a service application of the brakes is desired in the emergency position, emergency valve 206 is cut out by closing a stop-cock between it and the train line so that when slide valve 32 moves to the extreme left main reservoir pressure flows through port 42½, cavity 31a, port 115, through one end of the double check valve, through port 57, moving slide valve 35 to the right, making a service application, because port 80a is now connected to by-pass 40 by way of cavity 31 in slide valve 32 connecting port 33. It will be noted that when valve Z is open to the train line a service and emergency application is simultaneously made unless communication from 80a is disconnected from 80 by a suitable valve.

The Late James J. Hill and Associates

Long Island Changes Generator Suspensions

Truck Mounted Machines Placed on Car Bodies Show Economy By Giving Greater Belt Mileage

THE car lighting men at the Morris Park shops of the Long Island Railroad have been busy for some time in changing axle lighting equipment from truck to body suspension. Thus far only the Safety equipments have been changed over, but it is also contemplated to mount all of the Gould outfits now on trucks of steel cars, in the same manner.

The machines which have been changed are of the safety 4 kw. type. Forty-five coaches, five combinations, ten parlor and mail cars, a total of 69, which carries this type of equipment, have been changed over. In addition, three cars of the Safety 2.6 kw. type have also been changed to body suspension, the method used being a slight modification of that used with the 4 kw. outfits.

The type of suspension used is shown in Fig. 1 and has a number of features to recommend it. The supporting channel from which the generator is suspended is shown in detail sketch 1, and may be seen in place in assembly drawings *A*, *B* and *C*. This channel extends from the box girder in the center of the car to an angle iron at the side. Two rectangular openings 3 in. by 6 in. are made in the channel, through which the ends of the suspension yoke extend midway between these rectangular openings a 1 5/16 in. hole is drilled in the channel and when the suspension yoke is in place a king bolt is passed through the hole permitting a certain amount of rotation required in properly lining up the generator. This arrangement can be seen in drawings *A* and *C*.

The suspension yoke is shown in detail in sketch 4. It is made from cast steel and its outstanding feature is the circular bearing plate which is cast integral with the yoke. This extended bearing surface overcomes any tendency of the yoke to tip and prevents undue strain from coming on the king bolt. The yoke while of the channel type is re-enforced with webs for stiffness.

Such angular adjustments as are necessary in lining up the generator are made by two ⅝ in. bolts, extending through the side of the channel. These bolts are held in position by lock nuts. It will be noted in drawing *A* that the side of the channel iron through which the bolts are threaded has been re-enforced by an additional piece of iron which is riveted to the side of the channel. This was done in order to increase the amount of threaded hole through which the bolts extend as it was felt that the sides of the channel were hardly of sufficient thickness to give lasting satisfaction.

The method of supporting the generator from the suspension yoke is shown very clearly in drawing *B*. Two generator straps made of wrought iron or open-hearth steel are required as shown in sketch 3. These are slipped over either end of the generator and clamped firmly in place with bolts at the lower end. The supporting shaft, sketch 5, is inserted in the top openings of the generator straps, and securely pinned to them so that the shaft and straps move together. This operation is performed, however, after the generator has been lifted into position, as the shaft must also be passed through the steel bushings of the suspension yoke at the same time.

Provision is made on the generator straps for attaching eye bolts. On one of these straps two eye bolts are located as indicated in detailed sketch 3. In the hole at the side, an eye bolt is riveted which engages with the tension spring rod shown in sketch 13. The upper hole is used for the eye bolt to which the safety chains are connected. The second generator strap contains only the eye bolt for the safety chain. The detail of the eye bolt is shown in sketch 7. In connection with generator straps, it should be mentioned that the opening at the top between the two halves of the strap is welded shut after the two parts have been put together. The reason for this opening is that it avoids construction difficulties which would be present if an attempt were made to use but a single piece of iron for each strap.

The belt tension device used in connection with the body suspension is extremely simple. A tension spring bracket, sketch 11, is riveted to the under side of the center girder of the car as may be seen in assembly drawings *A, B* and *C*. This bracket is made of ¾ in. by 3 in. wrought iron or open-hearth steel, and has an arm which extends diagonally downward from the box girder to which it is attached. At a point directly behind the center line of the generator and in line with the eyebolt connected to the generator strap, the tension bracket is drilled with a 15/16-inch hole to accommodate the tension spring rod shown in sketch 13. The tension spring, sketch 8, is mounted on this rod. The tension spring seat which is riveted to the bracket, and the tension rod nut, are shown in sketches 10 and 9 respectively.

The lead cleat plate and lead cleat bracket are shown in sketches 2 and 6, and the assembly in drawings *A, B* and *C*.

For the greater part the foregoing detailed description is the one that has been used with the 4 kw. Safety type generator. In a very few special cases where the 2.6 kw. generators are used, the same suspension has been modified to accommodate the collar and lug with which these machines are equipped. The same supporting shaft is used, but it is necessary to slip bushings over it, outside of the lug of the supporting collar, in order to take up the space between the side of the lug and the suspension yoke.

Some of the cars on the Long Island have no brake beams between the axle pulley and the generator, and hence have no trouble with belts striking brake beams. On other cars in which the brake beams are present, it has been found that a very much greater belt life has been secured since the equipments were removed from the truck and suspended from the body of the car. With truck mounted machines, belts 11 ft. long were used, whereas with the new arrangement the increase in length of belt has only been approximately 3 ft. On parlor cars 14-inch axle pulleys are required on account of the deeper center girder, while on the coaches 17-inch pulleys are used.

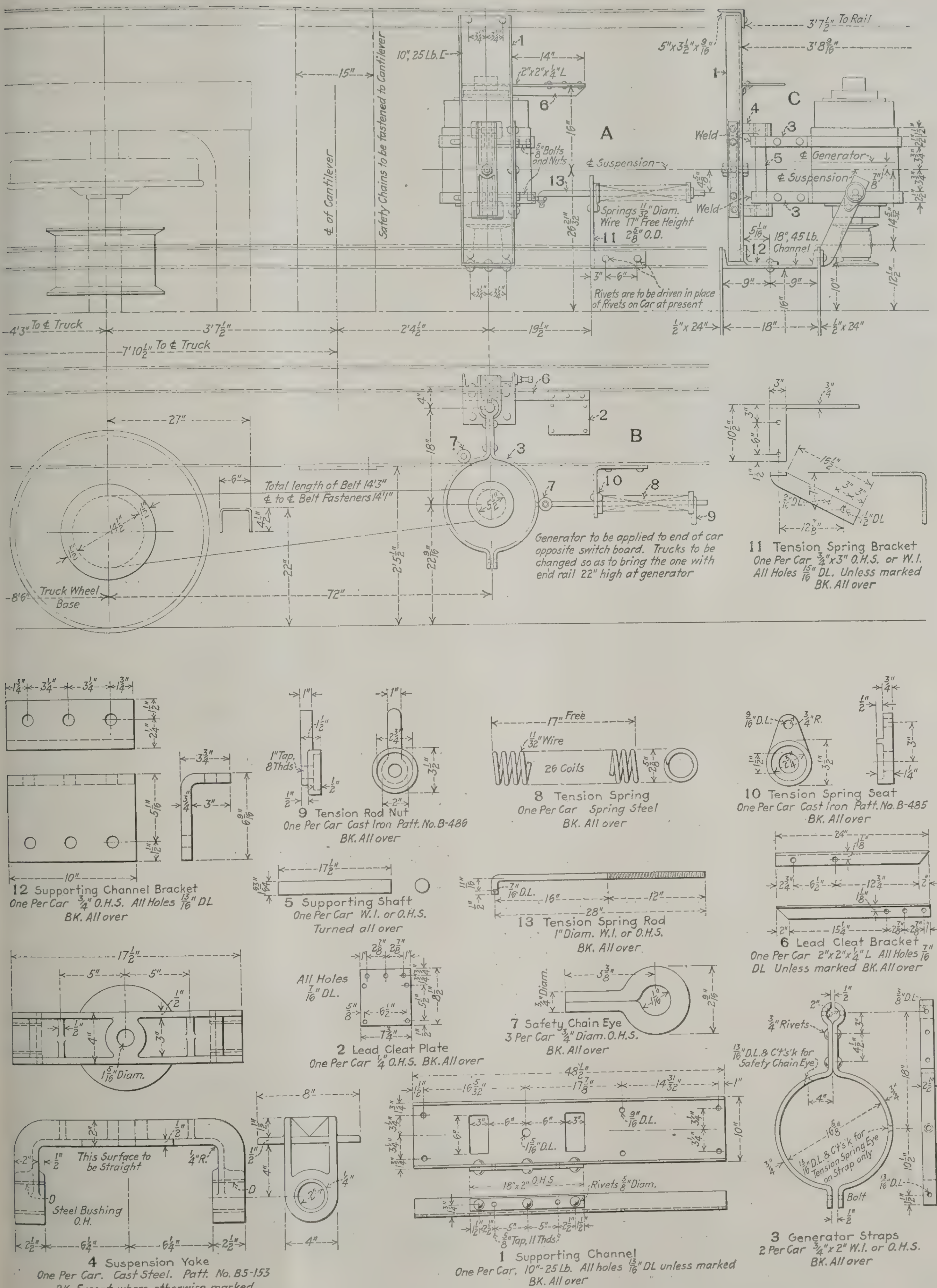


Fig. 1—Assembly Drawings and Detail Sketches of the Type of Body Suspension Used on the Long Island Railroad

The fact that the parlor cars have a deeper center girder is reflected in the additional length of the generator strap between the supporting shaft and the body of the machine. With the parlor cars it has been necessary to increase the length of this strap, but in all other features the suspension is identical for both types of cars.

Provision has been made by drilling holes in the suspension yoke above the supporting shaft to lubricate the shaft and bushing.

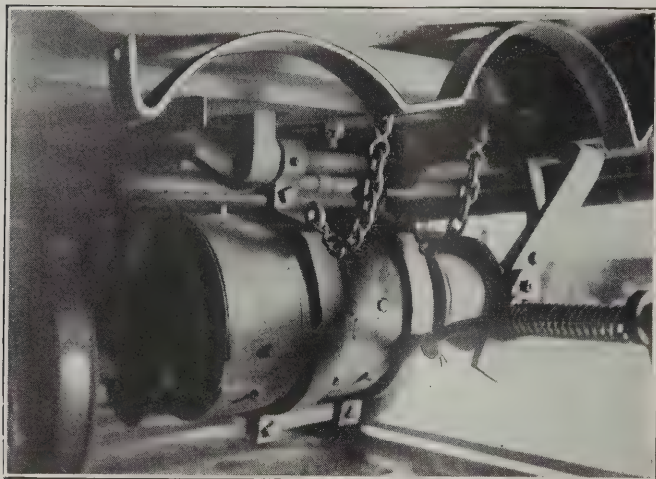


Fig. 2—Photograph Showing One of the Body Suspended Installations

The Long Island also has a large number of Gould equipments which at the present time are truck mounted, but which they expect to suspend from the car bodies as rapidly as their facilities will permit.

Reports on Electric Traction

At the ninth Congress of the International Railway Association which recently adjourned its conference at Rome, there were five reports on "Electric Traction." That for America was made by George Gibbs, chief engineer of electric traction of the Long Island. The other countries for which special reports were made were Holland and Great Britain, Belgium, Denmark, Sweden and Norway, Italy and Switzerland. It is somewhat gratifying to Americans to read in the report of Ernest Gerard, of Belgium, the statement that the United States "is still in the forefront for bold experiment in all directions of progress." The reports emphasize the fact that in countries or districts such as Italy and Switzerland, having numerous large waterfalls the problem of the production and transmission of the energy for electrification differs from that in other countries. It is found that in these and in the Scandinavian countries the managements of the railways are especially concerned that the energy from the hydro-electric generating stations shall be supplied under conditions which allow of its being used for general purposes as well as for traction on the railway itself. In other European countries, particularly Belgium, England, France and Holland, it has not been found desirable to adopt close interdependence between the production of current for electric traction and for other purposes.

The reporters agreed that the kind of current should be reduced to three types which can be recommended in practice for the electrification of large railway systems, viz., three phase at voltages exceeding 3,000 volts; single phase at voltages of 10,000 to 16,000 volts, and direct current at 1,500, 2,400 or 3,000 volts. It appears that single phase current at about 15,000 volts is preferred to all other types for economy in transmission, particularly when, as in Switzerland, it is carried direct in this form from the original source to the contact wire. The advantage of this diminishes where, as in Scandinavian countries, the energy must first be carried a great distance at very high voltage and reduced finally at substations.

Mr. Gerard's summary says: "So few are the financial figures supplied and so impossible is it to compare them, that it will be sufficient to state that there has been a unanimous wish expressed in favor of the adoption of a standard form of accounts referring the different factors to the same unit. . . . . The economic advantages of electric traction are not, and perhaps will never be, sufficiently evident to justify its universal substitution for steam traction."

Conclusions on Electric Traction

The following conclusions on electric traction were adopted:

"The Congress recognizes that at present no more than in the past, a single system could be recommended for all cases. Nor is it possible to choose between several systems, all of which have proved their value under most severe conditions of operation; the Congress recognizes, however, that these systems are all susceptible of considerable further improvements.

"The Congress agrees on the uselessness of standardization of the current in the contact wire on account of the ease with which locomotives may be changed at the frontiers of the different countries.

"It is desirable that the methods of keeping and supplying technical and economic information on electric traction should be defined and standardized, and with this in view the section suggests that this point be referred to a special committee of the association. This committee should draw up very fully the details governing each point, so that in the future as full a comparison as possible may be made by means of figures absolutely comparable."

Photo by Keystone View Co.

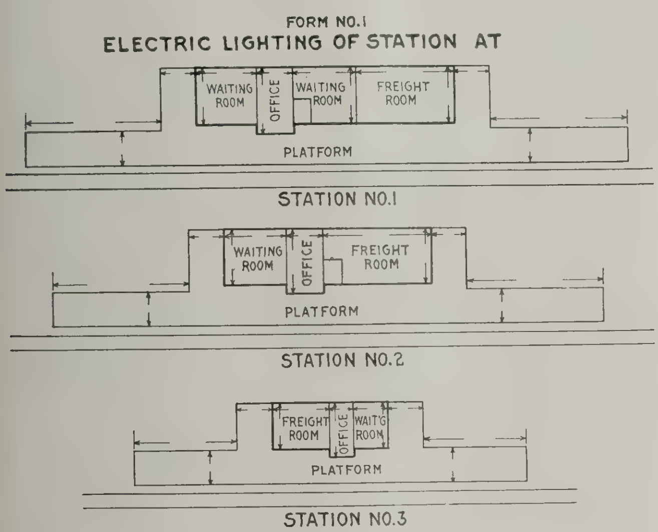
Summit of Pikes Peak, Colorado, with Rack Rail Car

Wiring Passenger Stations at Outlying Points

Cost of Work as Done by Railroad Forces Compared With Contractor's Bid

THE advantages of comparing the cost of having a certain piece of work done by a contractor with the cost of having it done by the electrical men on the railroad was discussed in the February issue of the *Railway Electrical Engineer*. In many cases it is not possible to make such a comparison, but where conditions permit, much useful information can be obtained and definite savings can be made. This method of comparison is used by a western road when it is necessary to wire a passenger station at some outlying point. The practice has provided a means for the electrical department to convince the management of the economy of doing the work in accordance with the railway specifications with its own forces as a general proposition.

When a request comes to the office of the electrical engineer from the chief engineer, or from some chief operating officer, asking for an estimate on the cost of wiring a certain station, the first action that is taken is to look up the architect's plan for the building. If no plan is available, Form No. 1 is sent to the station agent.



The diagram shows typical floor plans of standard stations No. 1, No. 2 and No. 3. Please indicate dimensions on the one which corresponds to your station. Mark with a cross where the electric service wires will enter the building. Show location of train order signal, if any.

Will Electric Light Company carry their wires to building free, and if a charge, ascertain how much.

Will meter be furnished free or on a rental basis?

What is the rate for current?

What is the present cost for oil lighting?

If your station does not correspond to either of the three shown, send pencil sketch of same. Also show whether or not there are living rooms, and if on the first or ground floor.

Return print with all data as quick as possible, with letter giving any other details.

A standard method of wiring has been developed for this kind of work and a wiring diagram conforming with this method is laid out on the architect's drawing or on the form as returned by the station agent. A bill of material is then made up from the wiring diagram on Form No. 2. Prices of material are added to this form by the price clerk and the cost of labor is estimated.

Form No. 2

The following material should be sent to....................
care ....account........................
........................Warrant No. ....

....	Steel cabinet 16 X........X 5. ....Amp.........Volt.
....	Knife switch, N. E. C. fused.
....	No. 40........panel cutouts.
....	........Amp.........volt, N. E. C. fuses.
....	........Amp. plug fuses.
....	3/16" x 1½" R. H. stove bolts.
....	Ft. ¾" galvanized conduit.
....	Ft. ½" galvanized conduit.
....	Ft. No. 12 R. C. D. B. wire.
....	Ft. No. 14 R. C. D. B. wire.
....	Ft. No. 14 R. C. Duplex wire.
....	Ft. No. 12 W. P. wire.
....	Ft. No. 18 reinforced cord, C. C.
....	Type F. 2 conduit fitting.
....	Type E. 2 conduit fitting.
....	Type F. S. 1 conduit fitting.
....	Type K. 1 conduit fitting.
....	
....	No. 23 Porc. covers.
....	No. 2500 Porc. covers.
....	No. 12 Porc. covers.
....	No. D. S. 8 covers.
....	No. C. C. 227 receptacles.
....	½" G. V. pipe cap.
....	¾" lock nuts.
....	½" lock nuts.
....	¾" bushings.
....	½" bushings.
....	½" pipe straps.
....	¾" pipe straps.
....	¾" ground clamps.
....	½" ground clamps.
....	½" fixture studs.
....	No. 6319 outlet boxes ½" K. O.
....	No. 6350 outlet boxes ½" K. O.
....	No. 6374 covers.
....	No. 6355 covers.
....	No. 6378 covers.
....	No. 4225 sockets.
....	No. 5070 sockets.
....	No. 50760 sockets.
....	No. 302 sockets.
....	No. 9407 sockets.
....	
....	Pendants.
....	Reflectors.
....	Glass shades.
....	Steel shades.
....	10" Asbestos shades.
....	D. H. push switches.
....	Meter board 9" x 12" x 1".
....	No. 4667 Pierce brackets.
....	No. 4671 Pierce brackets.
....	No. 32791 D. G. D. P. glass insulators
....	½" x 30" gocse necks.
....	No. 5025 pole pieces.
....	¼" x 2" lag screws.
....	⅜" x 2½" lag screws.
....	Doz. 1½"-8 F. H. wood screws.
....	Doz. 2"-8 F. H. wood screws.
....	1"-9 R. J. wood screws.

....	Lbs. 1½"-8 nails.
....	Lbs. friction tape.
....	Lbs. rubber tape.
....	Lbs. wire solder.
....	Sticks soldering compound.
....	25 watt, 55 volt, Carbon lamps.
....	40 watt, 115 volt, Mazda lamps.
....	25 watt, 115 volt, Mazda lamps.
....	
....	18 ft. standard wood platform poles.
	Above material required..................
	To be covered by req....................

A contract form which includes the specifications for standard wiring is sent to the local contractor with a request that he make a bid for the work. This form is shown as Form No. 3.

Form No. 3

We hereby agree to install electric light wiring in the ....Railway Company..................... located at .... in accordance with plans and specifications herein outlined for the sum of $..

Number and location of lights, outlets and switches as hereinafter listed and designated in accompanying blue print.

Method of Installation:

The system of wiring shall be a complete rigid conduit installation (where there are agent's living rooms above or in the same floor of the depot and when for this reason it is impracticable to run steel conduit BX or flexible Greenfield steel conduit with proper Underwriters fittings may be used.)

Service wire not smaller than No.... B. & S. gauge shall be used.

Service Entrance Switch:

Must be placed on all service wires either overhead or underground on the nearest accessible place to the point where they enter the building and inside the walls and arranged to cut off the entire current from the building. The service switch must be placed within seven feet of the floor and not more than three feet (in a horizontal direction) from the point where the wires enter the building and must be so located that the wiring between the service switch and the point of connection to the wires from the pole or underground conductors will be reduced to a minimum.

Service switch shall be of........... capacity mounted on slate with cartridge fuse extension, enclosed in a steel cabinet.

Service cabinet shall be supplied with meter loops and meter connections from cabinet to meter in conduit with proper condulet fitting at meter end.

A steel distribution cabinet shall be located in................ containing .... circuit switch panel cutouts.

....

....

....

Conduit entering service box must be locked and bushed thereto by means of locknuts and bushings. The end of conduit projecting from building into which overhead service wires are to be carried must be fitted with Type *F* Crouse Hinds condulet and cover.

All conduits shall leave cutout distribution cabinet going to outlet boxes and switches located.................................

....

....

....

All conduit outlet boxes, covers and fittings must be galvanized.

Conduit must be properly grounded.

All lights to be controlled from cutout switches in distribution cabinet except as otherwise shown on blue print............... circuits as per drawing. Living rooms and express rooms to be placed on separate meter, and not feeding through meter in ....

All conduit shall be properly reamed and where entering outlet boxes shall be secured thereto by means of locknuts and bushings.

All joints and splices must be properly made, soldered and wrapped first with rubber, tape and then with friction tape.

All wire shall be double braid rubber covered and no wire smaller than No. 14 B. & S. gauge shall be used.

Meter boards shall be provided and installed.

Meter shall .... be provided.

Fixtures and Locations:

....

....

....

Accompanying blue print to be considered as forming part of these specifications.

City permit and inspection certificate shall be procured and paid for by the contractor.

Work must comply with the ordinance of.................. and the rules of the National Board of Fire Underwriters and subject to approval of the Electrical Engineering Department before payment is made.

Work must be completed by..............................

Office of Electrical Engineer,

...................., 192 .

Accepted by

....

Accepted by

....

Original estimates are then remade to conform with Interstate Commerce Commission requirements and are submitted to the officer who asks for the estimate. If the contractor's figure is enough better than the estimated cost of having work done by the railroad forces, his bid is used in making the report.

When the work is authorized, either the contract is signed and sent to the contractor who made the bid, or if the work is to be done by the railroad forces, a requisition for material is sent to the electrical storekeeper. In the latter case the storekeeper ships the material to the point named and includes with it a list of all the material. In case some of the material is not on hand at the storehouse when the order is sent in, this material is ordered from the manufacturer or jobber immediately by the storekeeper and the items are marked B. O. (back order) in red. A contents list is sent with shipment and a duplicate copy to the electrical department so the electrical department can tell when all material is on hand.

When all of the material is on the ground the wireman or wiremen who happen to be at the point nearest to the station to be wired, are sent to do the work, a blueprint wiring diagram being sent to the point to be wired in care of station agent. These wiremen have permission to make slight changes in the running of circuits as conditions may require. In any case where the circuits are not run as shown in the drawing, these changes are recorded on the blue print which is given to the wiremen and this blueprint is returned to the office of the electrical engineer, together with the wiremen's report of completion of work. The tracing from which the blueprint was made is then changed to conform with the blue print.

In the rare cases in which a considerable change in layout is necessary, the electrician writes in notifying the office of the needed alterations, authority or instructions. Such a change may require more or different material which in turn will call for additional authority, but such a case is unusual and does not often change the cost of doing the work materially.

All surplus material is returned to the storehouse by the electrician. A copy of the credit slip shown on Form No. 4 is sent to the storekeeper and another to electrical headquarters. After this credit slip has been returned it is possible for the accounting department to make up

the necessary report to the Interstate Commerce Commission.

Form No. 4

MATERIAL CREDIT LIST

Material returned for credit to		Terminal Storekeeper General Storekeeper
Date returned	Passenger............Train No. via Freight............Car. No.	
Credit to (location)		Facility
A. F. E. NUMBER		Req. No.

NOTE: Electrician will make in duplicate and send original to storekeeper and copy to proper officer.

The final step in the work consists of checking the invoice of material with credit reductions issued by the accountant after the job is completed with the original bill of material, in order to avoid duplication and clerical errors and to see that all returned material has been properly credited and priced.

When the work is handled in this manner by the electrical department many difficulties and over expenditures are avoided. If some operating officer, etc., outside of the electrical department should obtain a bid from a local contractor, the bid price would be considerably less than the cost of doing the work by the railroad electrical department, but the difference would be due to the fact that the contractor was not required to bid on the work according to railroad specifications, and in cases where such specifications have been sent after the original bid was made, the contractor materially changed his bid. When an estimate is made according to this method no man is required to go out to the station and make out a bill of material and for this reason the cost of making the estimate is very low and no appreciable expenditure is made until after the work is authorized.

It must, of course, be understood that this method of estimating work applies to small stations, etc., at outlying points and not to the larger construction work.

Work has been pushed forward on the new "Aeroplane railway" which is to connect Nice and Monaco with Peira Cava, 4,500 feet above sea level. This "railway" will consist of four cables, attached to supports at heights varying from 15 to 100 feet, according to the contour of the land.

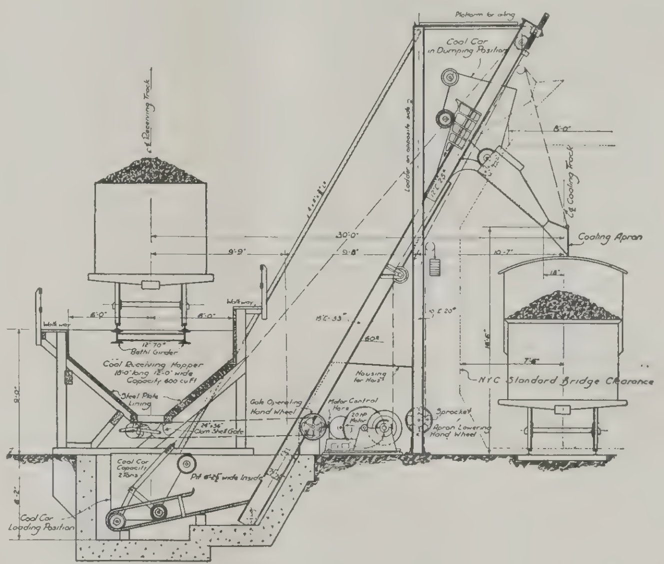
Photo from Keystone View Co.

Construction of the Tunnels Connecting Two Railway Stations in Brussels, Belgium

A Development in Locomotive Coaling Equipment

In the accompanying view is shown one of two small plants, one electrically and the other pneumatically operated, which have recently been developed by the Roberts & Schaefer Company, Chicago, to replace the old hand shoveling methods of coaling locomotives at outlying points, where the installation of more elaborate coaling facilities is not warranted, where the problem of engine coaling is of a nature to invite scientific treatment.

In these plants the coal is dumped from a gondola car into a receiving hopper, which can be designed for a capacity of 600 to 2,000 cu. ft. This receiving hopper is equipped with a 24-in by 36-in. clam-shell gate, which is operated by a hand wheel in the hoist house, thereby making it possible for the coal to be fed by gravity into a



Elevation of the Coaling Equipment

two-ton car below the hopper. This car when filled is then elevated by air or electricity on a structural steel supporting frame to the dumping point above the coaling track, where a hooded apron is provided, by means of which the coal is spouted into the tender. When dumping, the coal car or bucket is supported on substantial dumping castings, and when empty is returned by gravity to the loading position. The trip from the loading point to the dumping point and return takes about 1½ min.

The electrically-operated plant is provided with a 20 hp. electric motor, with Cutler-Hammer hand controller, solenoid brake and a machine time limit switch, which automatically stops the bucket at the dumping point, and prevents any overwind. The motor is direct connected through cut steel gears to a cast iron base winding drum hoist. Standard New York Central bridge clearances are adhered to in designing the structure, which makes it possible to install this plant on main line, or yard tracks.

The operation of the plant is simple, the regular shop or yard forces being able to take care of the coaling of the engines along with their other duties. It is therefore possible to release cars promptly and to avoid keeping laborers on duty at all times to shovel coal by hand. An additional feature of the plant lies in the adaptability of it for transferring material from bad order cars.

Handling Freight in the Country's Largest Terminal

Marked Reduction in Costs Obtained by Operating Electric Tractors and Trailer Trucks

THE Pennsylvania has recently revised its method of handling less-than-carload freight at its new terminal at Polk street, Chicago, with excellent results. Hauling by trailer trucks and electric tractors is the outstanding feature of the new system. Introduced in July, 1920, and enlarged upon in the following year, the equipment and the system built around it has operated to accomplish marked economies. The amount of labor required for the handling of the freight has been reduced more than half and the tonnage handled per man has more than doubled. Greater elasticity in performance has obtained, while business is handled with greater dispatch and less demand on floor space.

The Polk street terminal is a four-story structure, 450 ft. wide and 745 ft. long, which is built over 19 tracks with a standing capacity of 375 cars; the first or street level floor constituting the freight house proper and the upper three floors being utilized for storage by a warehousing concern. All merchandise is handled between the several floors and the track level platforms by 32 elevators, 8 of which are three-ton, 21 five-ton and 2 ten-ton.

From the opening of the building in 1918 to July, 1920, the hauling was accomplished by hand-trucking. The equipment consisted of the ordinary two-wheel trucks and 25 trucks of the four-wheel type, and the system required each trucker to push his load from the point of loading to its destination. Meanwhile the Western Warehousing Company, a subsidiary of the Pennsylvania, which occupies the 600,000 sq. ft. of storage room on the upper three floors, had adopted and was operating to advantage a system of tractor haulage, the warehousing equipment consisting of three tractors and 200 trailer trucks.

Hand trucking in the freight house never having been very satisfactory and having afforded little opportunity to reduce a considerable expense and annoyance of handling freight by this means in so large a building, observations were made of the warehousing company's system, and some experimenting was done on the freight house floor itself. As a result of these observations it was finally decided to inaugurate tractor haulage and pursuant to the decision four Mercury tractors and an equipment of trailer trucks were installed in July, 1920. In November, 1921, after 15 months of tractor operation the equipment was enlarged by the addition of two tractors and a sufficient number of trailer trucks in order to bring the total up to 725.

The System of Handling the Freight

The system under which the haulage operations are performed with this equipment is as follows: The building being divided into outbound and inbound sections; outbound freight delivered to the house by street vehicles is received at any one of 33 doors, unless it is a load of seven packages or less in which case it is received only at a package door, or unless it is a load of perishable freight when it is received only at a perishable freight door. At these doors the vehicle is met by a gang of three men consisting of a receiving clerk, truckman and loader, who with the exception of the gangs at the package and perishable freight doors, are assigned to two doors.

These men proceed to load the goods received from the vehicles upon the empty trailer trucks which are distributed by tractor under orders from a supervisor. Only that freight may be placed on any one truck which is to go into one car even though it amounts to no more than a single package. As soon as this freight is loaded on the trailer trucks, they are pushed to the nearest elevators, the average distance to which is 40 ft., where they are

A Typical Tractor Train on Freight House Floor

surrendered to an elevator man who lowers them to the track level and pushes them out upon the platforms. Here they are arranged into trains by a "floating stevedore" under a plan whereby all of the trucks for each track are assembled together. They are then picked up by a tractor and hauled to their destinations, the tractor in every case picking up the trucks as it proceeds from the outer end of the platform toward that end which permits it to pass around the end of the tracks.

The plan also provides that on any one trip only those trailer trucks are picked up for transit which are to be delivered to the platform for which the tractor train is en route. Having reached the platform in question, each truck is then set out at a point adjacent to the car in which the contents are to be loaded, this operation being performed by the one man, aside from the motorman, who accompanies the tractor train. When the freight is received by rail in trap or transfer cars the system differs only in the fact of its operations being carried on entirely at track level without the intervening steps introduced by elevator operation.

The Inbound Operations Are Just the Reverse

In handling inbound freight the packages are loaded upon the trailer trucks under a tallyman's direction and according to a plan whereby each truck is loaded only with that freight marked for the same destination in the house. After the trucks are loaded each truck is pushed to the nearest elevator where an elevator man raises it to the first floor, the operation thereafter consisting of its haulage by tractor to the proper destination which may

be in the alphabetical section of the house, such as Section D for Duncan Brothers, a section specially restricted for a particular shipper; the cold storage room, or a point where cars are loaded for the underground tunnel system. Arriving at these points, the trucks are uncoupled from the train and the freight is either unloaded or left on the trucks, depending upon the demand for trucks at the time and the likelihood of their being released within a period not to exceed 48 hours.

The trains ordinarily consist of seven or eight trucks but often carry as many as 14 or 15 loads, this loading being governed almost entirely by the bulkiness of the packages and operating convenience rather than by consideration of tractive power. As has been stated above, the tractor crew consists only of a motorman and an attendant although some conditions arise where it is found advisable to engage the assistance of additional attendants temporarily as where a long train of bulky material must be assisted around sharp corners or along narrow platforms of which there are several in the house.

TRUCKING OPERATIONS AT THE PENNSYLVANIA'S POLK STREET TERMINAL BEFORE AND AFTER TRACTOR INSTALLATIONS

The six months period prior to tractor haulage

Month	Number of truckers employed	Trucker hours	Tons handled	Tons per man hour
January....	195	43,651	37,038	.85
February....	183	48,763	45,940	.94
March......	328	85,023	56,611	.66
April.......	155	37,739	22,926	.61
May.......	199	49,785	38,104	.77
June........	256	69,674	55,107	.79
Average men per month	219.3	334,635	255,726	.764

The last six months of 1921 under tractor haulage

Month	Trucking force			Trucking hours				
	Truckers	Tractor operators and helpers	Total	Truckers	Tractor operators and helpers	Total hours	Tons handled	Tons per man hour
June...........	90	8	98	18,922	1,740	20,662	33,712	1.63
July...........	80	8	88	16,275	1,454	17,729	29,773	1.68
August.........	82	8	90	19,444	1,902	21,346	35,710	1.67
September......	84	8	92	17,815	1,782	19,597	35,256	1.80
October........	93	8	101	19,734	1,862	21,596	39,921	1.85
November......	86	12	98	17,964	2,346	20,310	37,356	1.84
Avr'ge men per month.......	85.8	8.7	94.5	110,154	11,086	121,240	211,728	1.746

Marked Results Have Been Obtained

The benefits which have arisen from the tractor operation are several. A comparison of the records for the

Tractor Trains Operating on the Track Platforms

last six months of this year with those for the six months immediately preceding the inauguration of the present system bring this out. As the accompanying table shows, between these periods the average number of tons handled per trucker has been increased from 1167 to 2228, or 90 per cent, while the number of tons handled per man per hour has been increased from an average of 0.764 to 1.746 or 128 per cent, or if compared with the records of the last three months of the year from an average of 0.764 to above 1.80. This reduction in the forces actually handling the freight has also permitted some reductions to be made in clerical forces. The average size of the gangs receiving the freight from vehicles and of those loading or unloading the cars has been reduced from 6 or 7 men to 2 and 3. It has also been possible to cut down the distance through which the truckmen are required to operate from an average of 1,000 ft. or more to less than 50.

One interesting point which arises in studying the system in use at the Polk street terminal is that the benefits which are now accruing from it are the results of considerable development and have increased steadily as the men have become more accustomed with the system and as the amount of equipment has been enlarged. A good indication of this is furnished by the fact that while the average tons handled per man per hour was 1.20 for the first six months of 1921, it has increased to an average of 1.76 for the last six months and for the last three months the figure has averaged above 1.80.

We are indebted for the above information to E. H. Kirkland, freight agent, and Oscar Hess, general freight foreman, of the Pennsylvania Terminal, under whose direction these trucks have been installed.

The gauge of the railway line from the port of Windau east to Mitau, on the line to Moscow, will be changed from the present standard to the old Russian gauge, which is 5 feet wide, according to a report from Trade Commissioner R. Lawrence Groves, at Riga. From the port of Libau to the Russian railway system the gauge will also be widened. These changes will eliminate the interruption due to the freezing up of the port of Riga.

A Bridge on the Chilean State Railways

The Hair Restorer Back-Fired

Unusual incidents and accidents often serve to fix in one's mind important underlying principles which text books frequently fail to make one appreciate. The peculiar behavior of a certain motor on a western road was so astounding that its action was difficult to account for until careful investigation led to the cause, after which it was simple enough, as are most things of this sort when they are sifted to the bottom.

This particular motor was used to drive what was locally designated as a hair-picking machine. The machine was a home-made affair, consisting primarily of a cylinder on the periphery of which protruded a large number of spikes. Its mission in life was to rejuvenate sleeping car bedding. Matted hair or moss taken from mattresses, or cushions, dust and all were fed into the machine.

"Back Came the Hair Dust and All"

The motor used to rotate the cylinder of the hair-picking machine was a 5 hp. compound, direct current motor, and had always been a faithful servant until one day it was loaned to a car lighting man to drive an axle generator that he was testing. Later, it was returned and once more attached to its original load.

It was Joe's job to feed the matted hair into the hungry maw of the picker and when he began his work it didn't take him long to come to the conclusion that the motor had been in bad company while away, and had acquired some very undesirable habits. He couldn't make it perform as it should at all.

The chief electrician of the road was doing some inspecting in the yard that day and Joe availed himself of the opportunity to ask the man with the brains what was the matter with the motor. With a duly important air, the chief electrician threw in the starting switch. Away went the motor as merrily as ever with apparently nothing the matter, but to make sure the C. E. picked up a large chunk of matted hair and fed it to the machine. The result almost overwhelmed him figuratively and physically. When the teeth began to take hold of the hair something happened. Back came the hair, dust and all, which all but smothered the poor C. E. When he recovered himself sufficiently he pulled out the switch and sat down to wait until the dust clouds settled.

While he sat there he came to the realization that the machine had been running in the reverse direction. This had him stumped for awhile, but he gradually came to the conclusion that perhaps the series field connections on the motor were reversed. Upon examination of the terminal block, he saw that there was evidence that the connections had been disturbed and by further investigation found that the fields were then connected differential compound instead of cumulative compound. And so the mysterious behavior of the motor was accounted for.

He Wasn't Promoted

He grumbled.
He was willing, but unfitted.
He wasn't ready for the next step.
He did not put his heart in his work.
He ruined his ability by half doing things.
He tried to make "bluff" take the place of hard work.
He didn't learn that the best of his salary was not in his pay check.
He was always behind hand.
He didn't believe in himself.
His stock excuse was "I forgot."
He learned nothing from his mistakes.
He felt that he was above his position.
He did not think it worth while to learn how.—*I. C. Magazine.*

A Job at Last

The new governor received so many applications for jobs he announced he could give consideration to none. Then he got another letter:

"Dear Governor: I see by the papers you are going to take a month off to destroy thousands of applications for jobs. I should like to be engaged to tear up the letters."

Sand: For Man and Engine

Two engines came out of the house one day,
And off for the terminal, far away.
They left from the yards with a snort and a puff,
And out on the road with just tons enough.

And one went through
On schedule time,
And made the hills
With a steady climb.
The other failed
To make a win
While on the grades
And "doubled in,"
And left its cars
Along the way
For other trains
To move some day.

Now both of these engines were rightly manned,
But one of them failed for the lack of sand.

Two men, and they started in life one day,
And off for the terminal, far away.
They left from their youth, as we all must do,
And the road before them seemed good and true.

And one went through
On schedule time,
And made the hills
With a steady climb,
The other failed
To make a win
While on the grades
And "doubled in,"
And left his work
Along the way
For other men
To do some day.

They both at the start had an equal stand,
But one of them failed for the lack of sand.

Men are but "boys grown tall" and education is a process which goes on all through life. It by no means ends with school days, although altogether too many seem to think that it does.

The fellow who can make a program and carry it out, regardless of whether it is easy or not, is the one who gets ahead.

"It's fin t' begin at th' bottom if y' don't stop there."

Answers to Last Month's Questions

1. *What effect does platinum have used as a catalyzer in the manufacture of sulphuric acid for acid batteries?*

2. *Is it a good or bad indication when a thoroughly discharged battery "gases" immediately when put on charge at a normal rate?* H. C. B.

3. *Suppose a 110-volt motor designed for 10 amperes is connected to a 200-volt line with a 10-ohm resistance in series with it. When tested it was found to be getting too much current and it was decided to place a shunt temporarily around the motor to take care of the extra current. What would be the value of the shunt?* R. A. B.

* * *

1. Referring to the first question it may be said that sulphuric acid is manufactured by two different methods—namely, the chamber process and the catalyzer process. The acid made by the catalyzer process is a purer product than made by the chamber process. The catalyzer consists of a platinum tube which is electrically heated by means of resistance wires and the process is briefly explained as follows: Pure sulphur is burned to sulphur dioxide and this resultant gas is led over the catalyzer and in so doing is changed into sulphur trioxide. This sulphur trioxide is then led into water with which it combines chemically to form sulphuric acid.

2. A discharged storage battery which gases freely when put on charge would indicate that the plates had become highly sulphated and that the gassing was probably caused by the electrolysis of the electrolyte. When the plates of a storage battery have been so completely discharged as to become heavily sulphated, the normal charging current, if applied, would be too high and would cause gassing and decompose the electrolyte. If the battery is not so badly sulphated that it is worthless, a long charge at a low rate may restore it again to working condition. In any event the mere fact that gassing occurs is not proof that the battery is fully charged.

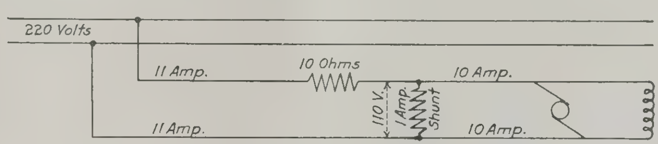


Diagram of Connections Referred to in Question 3

3. The drop through the 10 ohm coil is 110 volts. The current would be

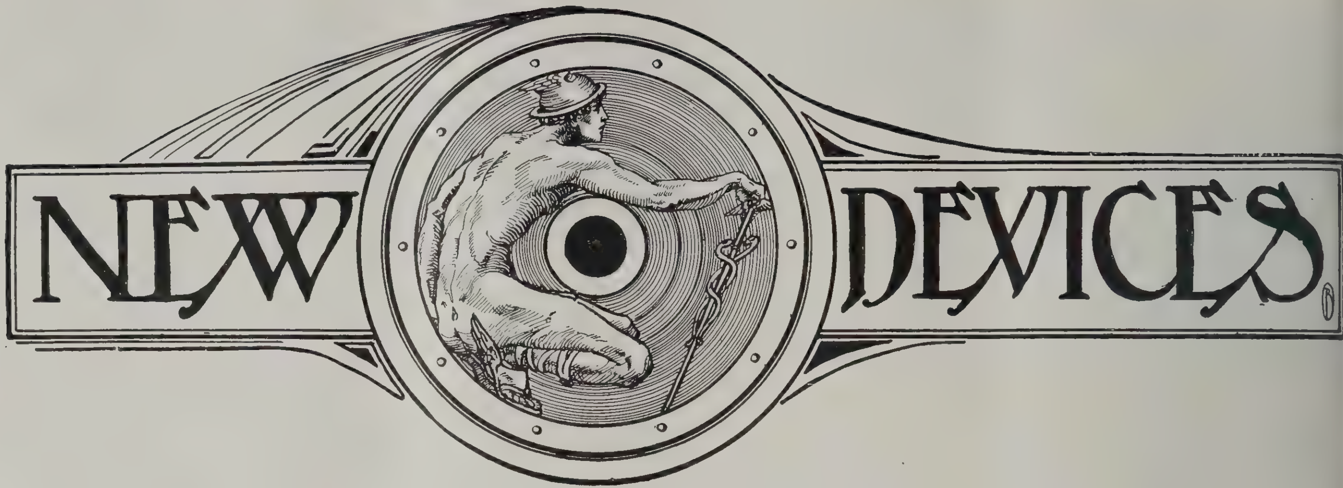
$$110 \div 10 = 11 \text{ amperes}$$

The pressure at different points on a parallel circuit will be the same so the pressure at the shunt will be the same as that at the motor, or 110 volts. Therefore, the voltage 110 divided by the value of the extra current of one ampere gives a result of 110 ohms which is the value of the required shunt.

* * *

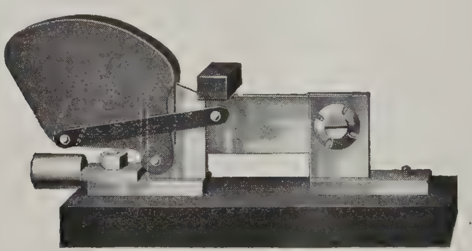
Questions for June

1. *I have never noticed any questions pertaining to radio in the "Railway Electrical Engineer," but I should like to ask your opinion on one or two points concerning this subject. What causes messages to fade away at times? Is a bright starlight night the best time to expect good results? How does daylight effect reception of signals? What effect does rainy weather have? What type of aerial do you believe to be most satisfactory? Are the best results secured when the radio waves strike the aerial broadside or endwise? How far above a tin roof should the aerial be placed?—M. M.*



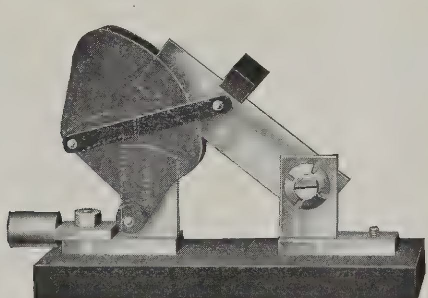
A Switch with a Moving Barrier

A new type of switch with a moving barrier which is interposed in the path of the arc and also prevents side flash has been developed by The Trumbull Electric Manufacturing Company, Plainville, Conn. The switch is designed particularly for service on 600-volt direct current circuits and is called the "Snuf-Arc" safety switch.



Blade in Contact

The switch blades and contacts are of regular 600-volt knife switch design. The barrier is made of moulded insulation and consists of two side plates or vanes which lie on each side of the switch blade connected by a curved section of insulating material shown by the dotted lines in the illustrations. The switch blades are operated by

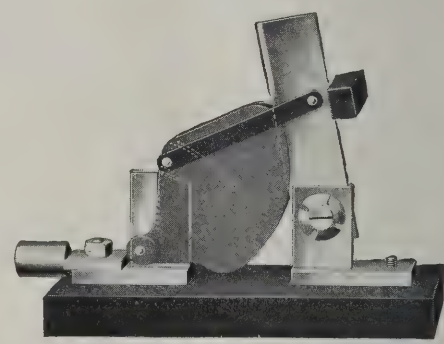


Blade leaving contact

an insulated connecting rod and when the blade leaves the jaw post the barrier instantly swings between the breaking points, extinguishing the arc by cutting it in two and preventing side flare.

When the switch is opened the side barriers swing with the blade in such a way as always to prevent a side flare of the arc. The center connecting barrier, shown by the dotted line near the center of the side barriers, swings with the blade across the top of the contact jaw, thus crossing the path of any arc that may have formed.

The switch is designed on the principle that an arc once formed can, as a rule, easily be broken by interpos-



Blade out of contact

ing some non-conducting material in its path. Interposing the non-conducting material increases the path of the arc and also cools the gases.

These switches are furnished for 600-volt circuits in capacities from 30 to 200 amperes. They may be had as single throw switches with 2, 3 or 4 poles without fuses or with fusible bottom.

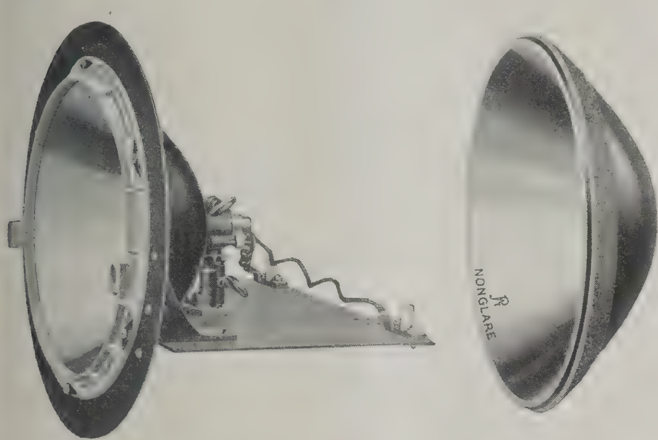
Locomotive Lighting Equipment

Several newly developed lighting devices for use on locomotives have been placed on the market by the Pyle-National Company, Chicago, Ill. These consist of a glass reflector mounting for locomotive headlights, a 14-inch glass reflector, a cast metal headlight case and a rear tender lamp.

The glass reflectors are made either of clear glass or of a colored glass known as "Nonglare." These reflectors are made of a moulded heat-proof optical glass. They are fire polished on the inside and are annealed to toughen the glass, after which the back of the reflector is ground to a parabolic curvature. They are polished by a special process, and then chemically silvered. The silver is covered with an electrolytically deposited coating of metallic copper. For further protection, an additional backing is placed over the copper, which has acid, gas and

weather resisting qualities. It is claimed that the "Non-glare" reflector reduces the glare from the light without materially affecting the beam candle power. Either of the two reflectors can be furnished in 12- or 14-inch diameters with a focal length of 2¼ inches.

The interior headlight reflector mounting has been designed for the purpose of applying glass reflectors to the sheet metal headlight cases made by the Pyle Company. The reflector is encased in a drawn steel protector shell and is held in place by an aluminum ring. The mounting



Glass Reflector Mounting for Sheet Metal Headlight Cases and a 14-Inch Glass Reflector

is interchangeable with the 18-inch copper reflector.

The cast headlight cases are made either of cast iron, or of an aluminum alloy, and are provided with a 14-inch glass reflector, and a 250-watt, 32-volt lamp. A machine taper fit is provided between the door frame and the body of the case to make the unit smoke, dust and gas-proof. A goggle door lock of improved design locks the door when closed. A weather-protected, accessible junction is provided between the case and the locomotive conduit

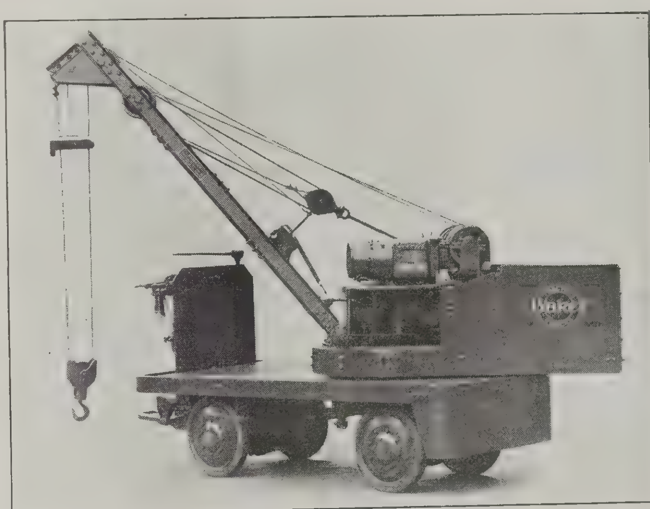
Headlight With Cast Metal Case

system. There is a pre-assembled, electrical distribution within the case, so designed that it is only necessary to connect the main leads with the distribution block in order to provide constant numeral light with full, dim and extinguished headlamp. The standard 14-inch cast iron case is 16½ in. high, 14½ in. deep, 18 in. wide and weighs about 85 lb. The cast aluminum alloy case is of the same dimensions and weighs something less than 45 lb. The body of both cases is cast in one piece.

The rear tender lamp is cast of a non-corrosive metal, is tapped at the top for ¾-inch conduit and is provided with three supporting lugs. The front door, into which a standard 5¾-inch white signal lens is secured, is hinged, leaving the interior of the lamp accessible for lamp renewals and wire connections. The door is fastened with a spring latch. A receptacle with lamp grips is used, and the connections to the receptacles are made in such a manner as to leave them accessible for testing the lamp circuit. A plate glass covers an opening in the bottom of the case through which a beam of light is thrown downward and outward, lighting the coupler and step. The beam of light through the lens is augmented by mirrors. The lamp is 7½ in. high, 8 in. wide and 5½ in. deep. It is claimed to be water-tight and constructed throughout to meet the most severe locomotive service.

Electric Crane Truck

An electric crane truck has been designed and built by the Baker R. & L. Company, Cleveland, Ohio, which is constructed on principles similar to those used in the construction of locomotive cranes. The complete equipment consists of a 3-movement crane mounted on the standard type QUQ utility truck, built by the Baker Company. The truck drives and steers on all four wheels and is driven by a 24-volt motor with a 72-ampere rating at 1,150 r. p. m. which has a 300 per cent overload capacity for 30 minutes. The motor is connected to the wheels through single reduction, worm drives, with 4-pinion differentials of the bevel gear type, radial and thrust ball



Three-Movement, One-Ton Electric Crane Truck

bearings, dished wheels with knuckle pivots over tire center lines, and full floating drive shafts. The controller is of the drum type which permits 3 speeds forward and reverse, and an automatic switch is provided which interlocks the controller and brake pedal. The brake is of the external contracting type operating on the worm shaft. A horizontal tiller steering handle is used and all steering levers and knuckles are fitted with renewable bushings.

The hoisting mechanism is self-contained with the battery compartment, the battery serving as a counter weight to the loaded crane. The operator, without leaving his position on the operating platform, can control the three movements of the crane and hoisting mechanism with

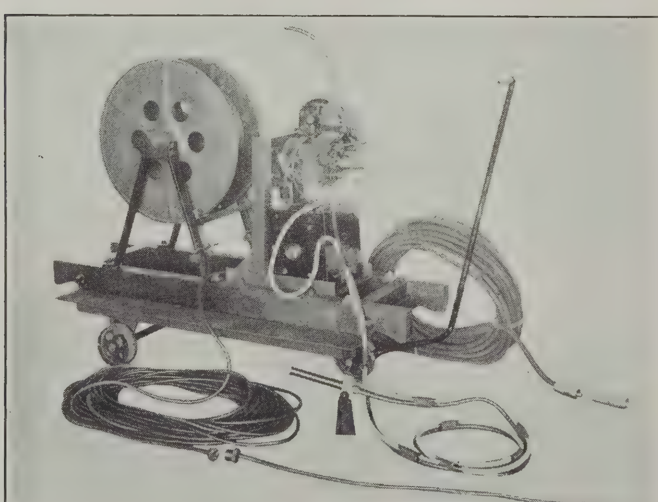
three push button control switches located on the dash. The three movements consist of raising and lowering the hook, raising and lowering the boom, and swiveling or slewing the crane and hoisting mechanism through an arc of 370 deg. All of these movements may be performed simultaneously.

The hook and boom are operated by two identical special Sprague one-ton hoists with spur and worm gear reduction. The motors mounted on these hoists are 24-volt, series wound, totally enclosed motors which are provided with electric brakes. A smaller, similarly designed motor is used for slewing, this motor being connected through a worm gearing to a spur pinion which travels around a large stationary bull ring gear mounted on the truck platform. The boom and hook are operated by their respective motors through double reduction spur and worm gearings.

The hoisting mechanism has a capacity of 2,000 lb. load on the hook with a 7-foot boom radius, the height under the hook for this radius being 10 ft. The hoisting speed of the hook is 45 ft. per minute with no load and 16 ft. per minute with a load of 2,000 lb. The time required to raise the boom through its complete travel is from 12 to 20 seconds with loads varying from nothing to 2,000 lb. The crane can be swung through an arc of 270 deg. in 20 seconds, and the truck operates at a speed of about six miles an hour. The weight of the outfit without battery is 6,000 lb., with 12 cells of 21-plate Ironclad battery is 6,840 lb., and with 24 cells of G-11 Edison battery is 6,710 lb. The rated capacity of hoisting and crane mechanism given above do not depend upon the use of outriggers to give the machine stability.

Portable Semi-Automatic Arc Welding Set

In order to increase the applicability of its semi-automatic arc welding apparatus, and make it available for use in any place where current for welding is available, the General Electric Company is now building a portable set.



This Semi-Automatic Set Can Be Moved to the Job

This comprises a complete semi-automatic equipment, with support for a wire reel, mounted on a small truck that can be pulled over the shop floor by hand, or lifted by a crane. The complete outfit weighs about 400 pounds.

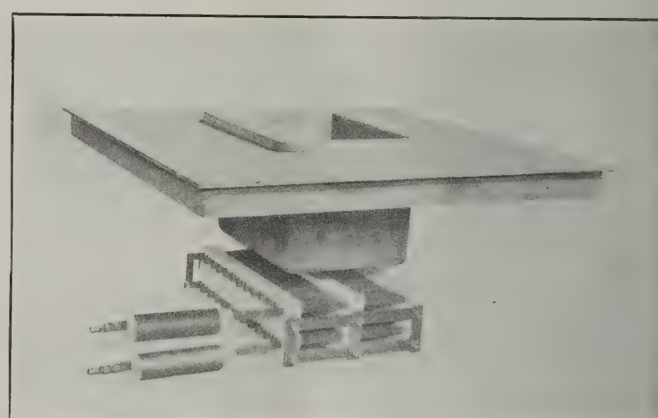
The welding equipment consists of a semi-automatic lead, an automatic welding head, with control, and a standard for holding a reel of electrode wire. Power is supplied to the arc through a flexible cable with a plug for attaching it to the nearest welding circuit. The reel carrier is equipped with a brake and designed to take any size reel up to 2½ feet in diameter.

The portable outfit should be valuable in repairing parts of machines in place when these parts are too bulky, inconvenient, or otherwise impracticable to move, and for doing routine welding of all sorts, such as filling holes in castings, welding seams in pipes or tanks, or other work of a similar nature. Besides the saving in time and trouble due to the portability of the outfit, its use will save both time and material in welding.

The electrode is fed continuously, the number of interruptions are reduced and less skill is required by the operator to make a good weld than is the case with ordinary hand welding. Material is saved by eliminating the waste ends which usually amount to at least ten per cent of the total amount of electrode wire used.

Electric Babbitt Pots

Two large sized, high temperature, automatic melting pots have been developed by the General Electric Company for melting large quantities of babbitt, solder and similar alloys or metals. The two devices are similar in appearance and construction and consist of a pot, supporting plate, heating unit, insulators and an automatic control panel with a temperature control instrument.



Electric Melting Pot Without Brick Housing

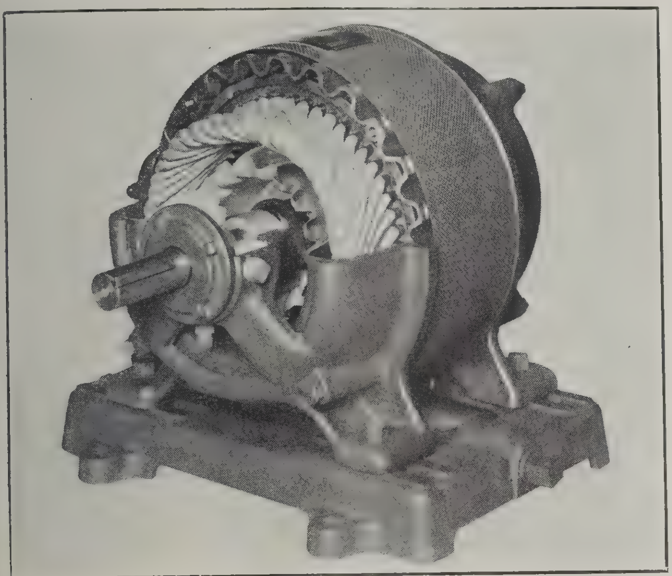
The pot and supporting plate are made of gray cast iron. The heating unit consists of a nickel-cromium alloy ribbon, which is formed, equipped with terminals, and assembled on the insulators which are made of a special compound.

One of the pots will operate at temperatures up to 800 deg. F. in the metal to be melted, requires 10 kw. of energy for operation, and is controlled by a Tycos mercury thermostat. The other pot will operate at temperatures up to 1100 deg. F. and is controlled by a Leads & Northrup single point potentiometer. The thermostat may be set for any desired temperature and will cut off the current at 5 deg. above the temperature and will close the connection again at 5 deg. below. Both of the pots have a capacity of 1,000 lb. of lead, 668 lb. of tin, or 920 lb. of babbitt consisting of 80 parts lead and 20 parts antimony. These pots are designed for use where larger

quantities of material are needed at one time, when the temperatures involved are higher or a quicker rate of heating is desired than is possible with the smaller self-regulated pot manufactured by this company.

Polyphase Motor with Unique Ventilating System

A line of polyphase induction motors has been brought out recently by the S. A. Woods Machine Company, Boston, Mass., which are so designed as to prevent the accumulation of oil on the motor winding and the resulting collection of dirt. The new Woods semi-enclosed 40-deg. induction motor, as it is known, is so built as



Ventiltaing Air Is Reversed to Keep Oil Out of Windings

to screen the ventilating air before it enters the windings and to direct this air so that it opposes the entrance of oil into the windings from the waste-packed bearings. The waste-packed oiling method has been adopted also to overcome any tendency toward the spilling of oil when vibration is particularly severe.

While the motors are ventilated or air-cooled they are virtually enclosed from a mechanical standpoint. Air enters at the periphery of the machine and is discharged at both ends, the direction of air flow being opposite to that found in most motors. It is claimed that oil leakage caused by careless filling of bearings cannot occasion bad results, because such oil is expelled from the ends of the motor instead of being driven into it.

The motor frame or casing is made from a single piece of corrugated sheet steel. The corrugations are equally spaced and in mechanical contact with the stator core, so that much of the heat generated in the core and its windings is conducted to the casing, which therefore forms a large surface for the radiation of heat to the ventilating air.

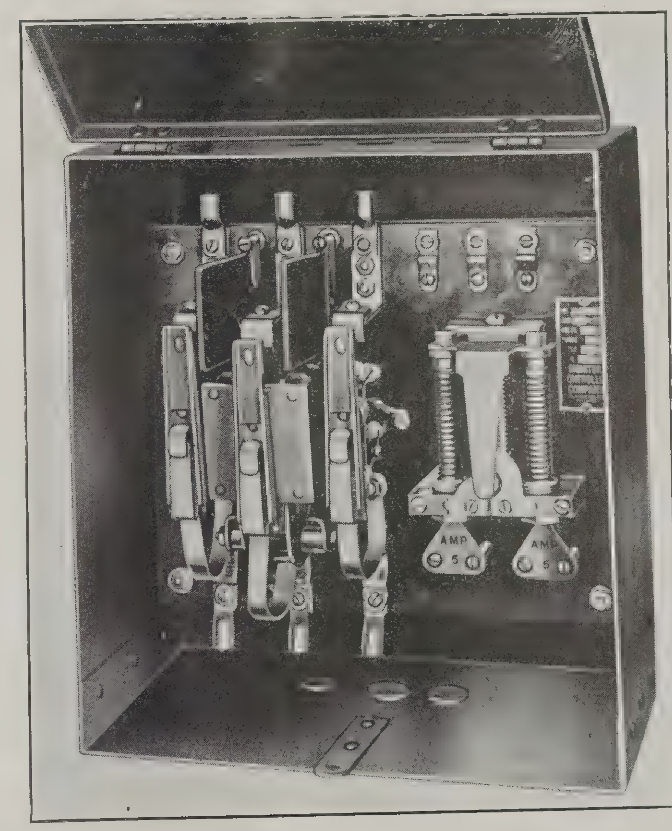
Air entering at any point along the surface of the screen travels over the outside of the corrugations through holes provided at the center of these corrugations, then through the lateral ducts between the casing and core, then over the windings at the end, and finally is discharged at each end of the motor.

Fans are provided at the ends of the rotor for the purpose of drawing the cooling air through the machine. They are of unique design and it is claimed that a stream of air is drawn directly over the bearing housing and immediately expelled without entering the motor, while another stream is drawn through the machine and expelled at the same points. These fans are made of a single piece of sheet steel welded to the thrust collars. Rotor windings are used which have bars and end rings made of one piece of metal, entirely eliminating mechanical or electrical joints, the windings being molded or cast on the magnetic core. The motors are built in sizes up to 30 hp. at 1,800 r. p. m. for 60-cycle polyphase circuits with corresponding capacities at other standard speeds and frequencies.

Across-the-Line Starter with Thermal Limit Protection

In protecting a motor from overload it is desirable to employ a device which will permit the use of the most favorable characteristics of the motor; that is, permit the motor to exert as much power as possible without allowing it to overheat sufficiently to cause injury to the insulation.

The Monitor Controller Company of Baltimore has recently developed a thermal-limit starter which will allow an induction motor to exert six or seven times its normal power for a limited period, and at the same time will protect it from a prolonged overload as small as 25 per cent.



Interior View of Starter Cabinet

When the starter is installed in the same room with the motor it automatically takes care of the change in load capacity of the motor with room temperature. For instance it reduces the prolonged overload capacity as

the temperature increases and increases said capacity when the temperature decreases, and yet it does not change appreciably the instantaneous load capacity of the motor.

This new starter, which has been named the "Thermaload Starter," consists of a standard Monitor type three-pole magnetic contactor, and a thermal-limit relay, of a new type that has just been developed. The two devices are mounted on a slate panel and enclosed in a metal cabinet which may be locked or sealed. The starter is of the remote-control type and is operated by push buttons from one or more points. It gives overload and low-voltage protection, prevents damage from single-phase running of polyphase motors, and yet gives a full-current, full-voltage, full-torque start. It is available in all sizes up to 3 hp. 110 volts single-phase, 5 hp. 220 volts single-phase, 110 volts polyphase, 10 hp. 440 volts single-phase, 220 volts polyphase. All sizes are available in voltages up to and including 550 volts.

The novel part of this starter is the thermal-limit relay which consists essentially of two units which expand between a fixed support and a hinged contact arm, the arm being arranged in such a way as to multiply the motion of the expansion units several times at the contact.

Each expansion unit consists of a double-wall tubular receptacle, the inner wall being smooth and closed at one end, while the outer wall is corrugated by a special process and closed at both ends. The space enclosed between the two walls is filled with tetra-chloride of carbon, a non-corrosive, non-freezing liquid.

The thermal element which operates the expansion unit consists of a form-wound coil of asbestos-insulated wire attached to a piece of insulating material by means of brass eyelets which are formed under pressure around the ends of the wire, thus forming the terminals. These eyelets register with two brass binding posts to which they are securely clamped by means of brass screws. Therefore, the binding posts in addition to serving as electrical connections to the element also furnish its mechanical support.

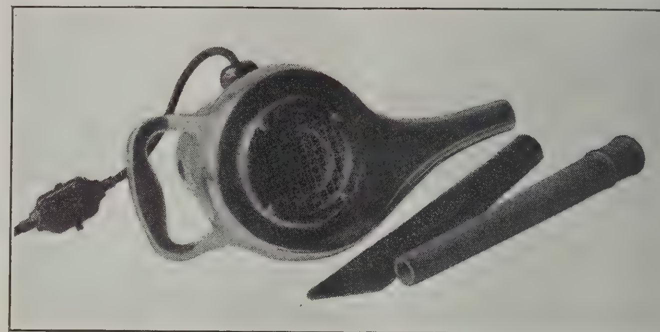
One of the most remarkable characteristics of this relay is the small amount of power required to operate it, namely: 2.14 watts. Since the power is low and the thermal element is in series with the motor the resistance of the element is extremely low, as is likewise the voltage drop. Thermal elements of 9 amperes capacity and greater are made of copper wire. Below this capacity a low-resistance alloy is used. The extremely low resistance of the thermal elements makes it possible to use a large diameter resistance wire, thus giving an element which is self-supporting and capable of withstanding rough usage.

The Thermaload starter has many advantages in the large industrial plant where motors of various sizes with various operating requirements are concerned, because the one type of starter will serve all the motors simply by inserting the proper thermal elements in the relays. To change from one rating to another it is not necessary to make any change in adjustment. The substitution of the thermal element of proper rating is all that is required.

The starter is complete and ready for connection to the circuits. There are no extra parts to be installed at the time the wiring connections are made.

Blower for Cleaning Machinery

A small easily portable blower designed particularly for cleaning electrical machinery has been developed by Charles W. Emery & Sons, Philadelphia, Pa. The tool is motor driven, and in design and construction is similar to a vacuum cleaner. It operates from a lamp socket and is furnished with either a soft rubber or hard fibre extension nozzle. The former is for use around machinery in motion and the latter for use on stationary



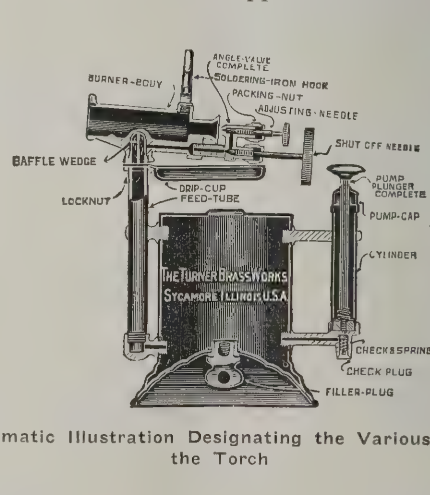
Cyclone Blower and Two Extension Nozzles

objects or idle machinery. The hard fibre nozzle is flattened for 5½ inches of its length to an outside dimension of 1¾ x ⅝ inches.

The case is made of aluminum and the total weight of the blower is 6 lb. The turbine is driven by a universal motor suitable for direct or alternating current from 0 to 60 cycles and for 110, 220 or 250 volts. Each blower is equipped with 25 feet of cord.

Blow Torch for Kerosene or Gasoline

A new type of blow-torch designed for burning low grade fuel has been placed on the market by the Turner Brass Works, Sycamore, Ill. The torch is fitted with the usual type of drip-cup for starting but has two control valves or needles. The upper needle with the small



Diagrammatic Illustration Designating the Various Parts of the Torch

thumb screw is used only to regulate the size of the flame, while the lower needle is used to shut off the fuel. This arrangement eliminates the possibility of enlarging the orifice by closing the shut off needle tightly while the torch is hot.

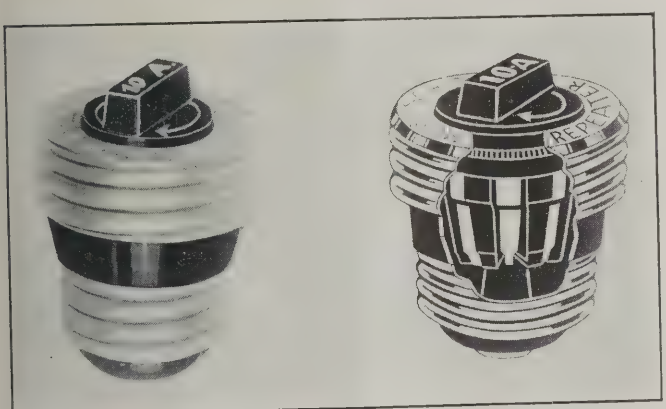
There is a small raised portion inside the burner known as the baffle wedge which is heated to redness

when the torch is in operation. As the fuel supply is in contact with the inner surface of the baffle wedge it is preheated to a high temperature before being admitted to the outlet valves. This factor makes the use of low grade fuel possible and increases the efficiency of the torch. To prevent any possibility of heating the fuel in the tank to such a degree that it would create gas pressure and cause an explosion the feed tube is placed outside of the tank. The hot gases are blown out of the orifice through a cone shaped tube into the burner and it is claimed that this conical tube will siphon the correct proportion of air into the burner regardless of the size of the flame.

The air pump is made on the parachute principle which allows air to pass by the plunger freely on the up stroke. On the down stroke the air inflator spreads the leather cup and air is forced into the tank. Provision is made for lubricating the pump and keeping the leather soft. The tanks are made of pressed drawn brass and all parts of the torch are standardized, thus making it possible to obtain extra parts.

Fuse Plug Repeater

An Edison type fuse plug which contains six fuses has been developed by the Moss-Schury Manufacturing Co., Inc., Detroit, Mich. The plug has a central rotating element which extends through the top of the plug and in which are mounted the six fuses with barriers between them. When a fuse is blown a new fuse can be placed in the circuit by turning the small raised portion one-sixth of a turn to the right. The body of the plug, instead of being made of porcelain, is made of a composition material which is not as brittle as porcelain and which has heat and moisture resisting properties. It is called the "Repeater-6" Fuse Plug and has been approved by the Underwriters' Laboratories. The plugs are furnished with ratings of from 3 to 30 amperes.

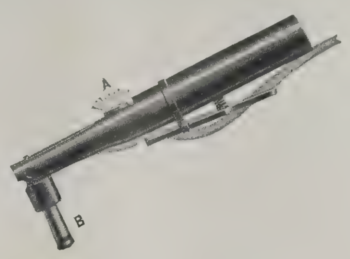


The Plug Contains Six Fuses Mounted as Shown at the Right

Storage Battery Cell Filler

A simple device for flushing storage battery cells known as the Exide Cell Filler has been developed by the Electric Storage Battery Company. The tool is designed to give a warning when the electrolyte in the cell has reached the proper level and thus prevent the damage which may be done by slopping the electrolyte over the tops and sides of the battery.

The rubber tube is connected to the distilled water supply and the trigger below the handle of the device controls the flow of water by pinching this tube. The nozzle end "B" is first inserted in the filling vent and when the trigger is pressed the water flows through the hose into the cell. As soon as the level of the liquid reaches the proper height, it causes a contact to be made and a small electric light bulb signal "A" lights. Releasing pressure on the trigger shuts off the water, and the operation is repeated in the next cell.



The Exide Cell Filler

Low Platform Electric Truck

An electric truck with an especially low loading platform has been designed by the Elwell-Parker Electric Company for handling barrels, bales, bags or heavy rolls. The truck is made up of about 95 per cent of standard parts on a special frame, and is designed for use where hauls are so long that a man with a hand chisel truck is too slow and expensive a means for the movement of material.

There is a storage battery over the driving wheels on the upper deck. The motor and worm drive axle are located under the upper deck. All four wheels steer and the raised portion near the end of the platform, known as the "kick-up," houses the rear wheels. The driving wheels are fitted with 21½ in. by 3½ in. rubber tires, and the trailing wheels with 10½ in. by 5 in. tires. The truck will run from 15 to 20 miles on a single battery charge.

The Truck Is a Drop-Frame Truck of Special Design

General News Section

C. E. Allen, manager of the central station division of the Westinghouse Electric & Manufacturing Company, with headquarters at Chicago, has been promoted to manager of the St. Louis, Mo., office, with headquarters in the latter city.

Western Pacific Railroad has placed an order with the McClintock-Mitchell Company for structural steel for one 210-ft. through-riveted electrically operated draw span, one 100-ft. through-plate girder, and one 80-ft. through-plate girder for the renewal of a bridge crossing the San Joaquin river near Stockton, Cal., this work to be undertaken by company forces during the latter part of July.

The Roller-Smith Company, New York, announces the following changes in its sales organization: The Perkins-LeNoir Company, who formerly represented the Roller-Smith Company in Philadelphia, has been succeeded by Messrs, Esherick & Hoyle, Otis Building, who will handle the Roller-Smith's line of electrical instruments, meters and circuit breakers in the Philadelphia territory. The Perkins-LeNoir Company, who formertly represented the Roller-Smith Company in Baltimore, has now been succeeded by J. E. Perkins, 113 East Franklin street.

Westinghouse Electric & Manufacturing Company announces the following changes in personnel: A. S. Duncan, storekeeper at the East Pittsburgh works, has been appointed general storekeeper of finished stocks with general supervision of warehouse organization and methods no matter where located. H. L. Jones, formerly assistant superintendent, has been appointed superintendent of the switchboard and detail department; A. J. Bastian, formerly assistant superintendent, has been appointed superintendent of the insulating department; W. H. Miller has been appointed supervisor of tools and gauges in the inspection and testing department; and W. F. Ablauf has been appointed supervisor of mica and mica processes in the inspection and testing department. All appointments are at the East Pittsburgh works.

The Westinghouse Electric and Manufacturing Company has recently erected, and is now occupying, the Westinghouse Electric Building, at Second Avenue and Ninth Street, in Huntington, W. Va. In the new building, the activities of the sales, service and warehouse departments have been co-ordinated. The building is a three-story structure containing 30,000 square feet of floor space with convenient railroad sidings. The service department is well fitted to quickly repair all classes of electrical apparatus. The department maintains close contact with the engineering department at the Westinghouse East Pittsburgh Works and engineering advice is immediately available. Arrangements have been made to furnish steam and electrical engineers to install, inspect and repair equipment in the field.

Charles A. Coffin, of the General Electric Company, Schenectady, N. Y., and the Thomson-Houston Company, one of its predecessors, and who for 40 years took an active part in the development of these corporations, resigned as chairman of the board on May 16. Mr. Coffin will continue as a director. Owen D. Young, vice-president, succeeds Mr. Coffin as chairman, and Gerard Swope, president of the International General Electric Company, an affiliated organization, has been elected president. Anson W. Burchard, a vice-president of the company, has been elected vice-chairman of the board. The title of honorary chairman has been created for E. W. Rice, Jr., who was president for eight years. The board was increased by the election of J. R. Lovejoy and George F. Morrison, both long associated with the company as vice-presidents.

Special Train from Chicago for June Convention

For the convenience of persons going to Atlantic City to attend the convention of the Mechanical Division of the American Railway Association, which meets from June 14 to 21, inclusive, the Pennsylvania System will run a special train leaving Chicago at 1 p. m., central time, on June 12 and arriving at Atlantic City at 10:45 a. m., eastern time, on the following day. The train will consist of club, open section, drawing room and compartment cars, and a dining car.

$8,000,000 Placed in Contracts for French Electrification

A quantity of equipment for electrifying 125 miles of main line, including 80 freight locomotives and 80 passenger motor cars, is to be furnished to the Paris-Orleans Railway by a group of French manufacturers headed by the Compagnie Francaise Thomson-Houston. The Paris-Orleans Railway is one of the six large systems of France which operate something more than 5,000 miles of route. The C. F. T. H. Company is the representative of the International General Electric Company. The 1,500-volt direct current system will be used and, according to dispatches received recently, this installation is the beginning of a more extensive program. The greater part of the equipment will be manufactured in France, but it is understood that considerable material of American manufacture will also be required.

The locomotives will be used on an extension of the original electrification, made about 25 years ago by the French Thomson-Houston Company. The first section of the new 1500-volt section will cover 125 miles of main line between Paris and Vierzon. The motor cars will replace and extend the present suburban steam service out of Paris.

According to plans, high speed through passenger service from Paris to Vierzon will be handled by 1,500-volt, direct current electric locomotives weighing 125 tons

each and capable of regular running speeds of between 80 and 85 miles an hour. These locomotives are not included in the contracts thus far awarded, but the railway company is expected to announce the placing of this business at an early date and to give consideration soon to the purchase of additional locomotives for use in the Central Plateau Region.

Railway Extension and Electrification in Java

Steady progress is being made on the construction of the railway line between Martapoera and Banjoeberang, Java, according to Commerce Reports. One section of this line was opened to traffic in October, 1921. A new line is projected between Macassar and Boni Plain in Celebes, but this project has not yet taken definite form.

The estimates made in the Netherlands Indian budget for the electrification of the railways of Java have been accepted, but no time has been set for the beginning of the work. A German concern has recently sent a special representative to Java for the purpose of studying the plans and making competitive bids on machinery and supplies.

Electrification Progress in Italy

Some most interesting statements were recently made by the Director-General of the Italian State Railways at the ninth Congress of the International Railway Association at Rome in reference to the electrification of the Italian lines. "The problem of electric traction," he said, "has been the subject of our most profound study. After the experiments on the Milan-Sondrio-Tirano lines and the Milan-Varese line, the first worked by an overhead wire at a tension of 3,000 volts, and the second by a third rail, experiments made by the former railway companies, the administration of the state railways decided definitely to adopt the system of overhead wires even on the steepest gradients. They began with the two lines of the Giovi, which have become insufficient to carry the enormous traffic of the port of Genoa.

"The benefits obtained by this first application suggested the study of the vast problem of electrification. The difficulties of the war obliged us to delay the work already commenced. When hostilities ceased these experiments were actively renewed; a vast plan of accurately organized work gives us the certainty that six or seven years hence it will be possible to work by electricity about 3,125 miles of heavy traffic lines in our country. Today the lines Bologna-Florence, Faenza-Bologna, Genoa-Pisa, Rome-Tivoli, Rome-Anzio-Nettuno, are being electrified. The work on the Ronco-Trofarello line has recently been completed."

Because of its many mountains and the extremely high cost of coal, conditions in Italy are very favorable to electrification.

Following the opening session the congress was divided into five sections. Each section has its own president, vice-president and secretaries. The subjects considered by the different sections are classified under the following general headings:

1. Ways and Works.
2. Locomotives and Rolling Stock.
3. Operation.
4. General.
5. Light Railways.

The various reports which have been prepared are first submitted and discussed in the sectional meetings. Conclusions regarding each question submitted for consideration are drawn up and adopted in the sections. Each set of conclusions will be reported next week to the general meeting and modified, rejected, or accepted by it.

George Gibbs, chief engineer of Electric Traction of the Long Island Railroad, was elected president of Section 2. General W. W. Atterbury, vice-president of the Pennsylvania Railroad, was elected vice-president of Section 4. These are the only officers of American railways who have been elected officers of the sections.

Personals

O. A. Lawrie has been appointed district sales manager in the New England territory, with headquarters at Boston, Mass., of the Ohio Brass Company, Mansfield, Ohio. For the past 16 years Mr. Lawrie has been with the American Copper Products Company, Bayway, N. J.

Louis W. Sipley, formerly sales engineer with the Electric Storage Battery Company, Philadelphia, Pa., has been appointed sales engineer for the Safety Car Heating & Lighting Company, New York. Mr. Sipley's headquarters are in the Commercial Trust building, Philadelphia. He is a graduate of Bucknell University, holding degrees in both mechanical and electrical engineering. While with the Electric Storage Battery Company, his duties included handling the power plant and railway sales.

F. S. Hunting, for the last several years general manager of the Fort Wayne section of the General Electric Company, is leaving that company and soon will take charge of the Robbins & Myers Company, Springfield, O., of which he has been elected president and general manager. The section of the General Electric Company of which Mr. Hunting has had charge, and the Springfield company, have manufactured much the same products. Both are prominent in the fractional horsepower motor field. Mr. Hunting, for thirty-four years interested in manufacturing electrical appliances at Fort Wayne, has lately had charge of manufacturing and sales of the company for the Fort Wayne division. His supervision has been given both to the operation of the Fort Wayne plant and to the general sales policy for the entire line in that plant and others of the company contributing to the small motor and allied business.

F. S. Hunting

Mr. Hunting was born in 1867 at East Templeton, Mass., where during his school life he helped his father in his widely known furniture factory. He graduated from the Worcester Polytechnic Institute in 1888. That

year he went to Fort Wayne with money derived from winning one of the high places in his class standing. Starting as a draftsman in the Fort Wayne Jenny Electric Light Company, he gradually worked his way to the position of chief engineer. Later when the company changed hands he became vice-president and sales manager. That was in 1899. The same year in another reorganization he was made treasurer and salesmanager. A few years later, when the General Electric Company assumed complete control and the operation of the Fort Wayne industry, Mr. Hunting was placed at the head of the works, both as manager and in executive charge of the sales policy of the division.

In recent months there has been a large increase in the volume of business done by the Robbins & Myers Company, according to statements issued by the company. Bankers of New York, Cleveland and Chicago have agreed to refinance the company. This is being carried out at the present time.

E. P. Waller, assistant manager of the railway department of the General Electric Company, Schenectady, N. Y., has been appointed manager of the railway department. J. G. Barry, who has heretofore held the positions of general sales manager of the company and manager of the railway department, will in the future devote his entire time and attention to the work of the sales managership. Mr. Waller was born in Martinsville, Va., and was graduated from the Virginia Polytechnic Institute in the class of 1900. Following his graduation he entered the testing department of the General Electric Company at its Schenectady Works. After two years in that department he joined the staff of its publication bureau and later served as associate editor of the General Electric Review. In the fall of 1903 Mr. Waller took up commercial railway work under Mr. Barry and in 1912 he was appointed assistant manager of the railway department, which position he held at the time of his recent appointment as manager of that department.

E. P. Waller

Obituary

Leo Daft, one of the pioneers in the electric railroad field, died on March 28, 1922, at Albany, N. Y. Mr. Daft was born in Birmingham, England, November 13, 1843. In 1859 he entered London University as a special student in civil engineering, and at this time became acquainted with Sir William Siemans who aided him in carrying out his electrical experiments. He came to the United States in 1866 and the first work done in this country was to assist in making extensions of the Louisville & Nashville Railroad, then in course of construction.

His first venture in the electrical field was with the New York Electric Light Company, which was soon merged in the Daft Electric Company. This company was almost exclusively devoted to the development of electric power machinery, and was responsible for establishing several power stations in Boston, New York, Worcester and elsewhere. In 1883 Mr. Daft built an electric locomotive named the "Ampere" for use on the Saratoga and Mt. McGregor Railroad, and in the following year he installed short lines at Coney Island, N. Y., and elsewhere. In August, 1883, he put into operation what was probably the first electric elevator in the world, at the Garner Cotton Mills, Newburgh, N. Y. In 1884 he supplied the machinery for the New York Power Company's Gold street station. In 1885 he furnished electrical equipment for a branch of the Baltimore Union Passenger Railway Co. This road was one of the first commercially operated in the United States. In recent years Mr. Daft directed his attention principally to the electrochemical field, having invented a process, whereby rubber can be vulcanized directly on to metal, making a bond having a greater tensile strength than the rubber itself.

Trade Publications

The Black & Decker Mfg. Co., Baltimore, Md., has recently issued a new miniature catalogue of 20 pages illustrating and describing portable electric drills, grinders, etc. Prices are given with each description.

Hazard Manufacturing Co., Wilkes-Barre, Pa., has recently published a 16-page booklet describing the specifications and manufacture of Hazard Keystone Wire. The book gives some interesting engineering data concerning the properties of rubber insulated wire.

Sprague Electric Works of the General Electric Company has recently issued two illustrated bulletins. The smaller describes the narrow-unit panel boards of the safety type. The second pamphlet describes the Sprague system of electric motor drive and control for newspaper presses.

Shurvent Protection is the title of a folder which has just been published by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. The folder explains the application and design of fuses for the protection of low-voltage circuits up to 600 volts for both alternating-current and direct-current.

Every part of the Shurvent fuse is described in this folder and sketches are used to show how the renewal of both the ferrule and knife-blade types of fuses is accomplished. Other subjects are covered, such as the conditions which must be met to obtain the underwriters' approval, style numbers, weights, prices and other tabulated data.

Welding Rods and Electrodes.—A 40-page handbook known as Catalog No. 500 has recently been issued by the Page Steel & Wire Company, Bridgeport, Conn., which gives a variety of information concerning Page-Armco welding rods and electrodes for oxy-acetylene and electric welding. The catalog is well illustrated and in addition to the welding rod data, it contains a fund of miscellaneous information useful to the welder concerning the metallurgy of iron and steel, amount of welding material required per lineal foot of weld, definitions of electrical units, mensuration factors, wire gage table, etc.

Railway Electrical Engineer

Volume 13 JULY, 1922 No. 7

Standards for Welding Apparatus

It has been pointed out by Comfort A. Adams, director of the American Bureau of Welding, that while there are now a number of types of arc welding apparatus being sold, in the past there has been no agreement among the manufacturers as to the basis of rating the machines. A prospective purchaser is bewildered by the confusing claims that special merits pertain to the different machines on the market and unless he has had previous experience in welding, he has no sound basis for comparing the capacities of the several makes.

To supply this need, a report on standardization rules for arc welding apparatus, published elsewhere in this issue, has been prepared for the American Bureau of Welding by its sub-committee on standards for arc welding apparatus. This committee recognizes the American Institute of Electrical Engineers as the authoritative body controlling the standardization of electrical apparatus and has therefore submitted the report to the standards committee of the A. I. E. E. for revision and approval. The rules contained in the report have been approved by the American Bureau of Welding for a period of one year and it is hoped that by the end of that trial period these rules or a revision of them will have been adopted by the standards committee of the A. I. E. E. These rules should be of immediate benefit to the welding industry as it is probable that such revisions as may be made in the future will be minor changes and will not materially affect the rules as they now stand.

Electric Rivet Cutting

Cutting off rivet heads with the electric arc is a process which promises to make a place for itself in railroad work. It may be applied to work on steel cars, boilers and in fact to almost all classes of work requiring the removal of rivets. Both alternating and direct current machines are available for this purpose, these machines differing somewhat from those used for welding, since the values of current and voltage used for cutting are relatively high.

Cutting out rivets with the gas flame is a practice which is quite common in railroad shops while the use of the electric arc for this purpose is comparatively new. Numerous objections have been raised from time to time to the use of the electric arc for rivet cutting, but one by one they have been disposed of and several railroads now use the process. Damage to the plate is offered as an objection but anyone who has watched the work has noticed that the arc sticks to the rivet after it has been started and does not wander around on the plate as might be expected, even though the rivet is burned completely out of the hole. Mechanical and inductive "kick" have been practically eliminated.

The comparatively large amounts of power required for cutting call for the use of heavy welding leads and rather bulky electrodes. On the Chesapeake & Ohio the welding machine is connected to a bus to which are connected in turn a number of welding leads. The cutting electrode only is carried about and the dragging of heavy leads is eliminated. The fact that the electrodes are large makes them difficult to use in confined places, but that does not materially affect the range of applications of the process and there is apparently a large place in the railroad field for electric arc cutting equipment.

The Lesson of the Convention

The Atlantic City conventions in June were most decidedly successful from every point of view and particularly so from that of the electrical men. The period may be set down as marking the beginning of a new era for the development and growth of electrical activities in the steam railroad field. It is not so much that any spectacular spurt has been recently made in the adoption of electrical equipment at it is that a better realization of the importance of this constantly growing field has been forcefully brought home to the higher executives.

The increase in the use of electrical energy has been gradual. It has crept into practically every department, performing such important work that should it be suddenly removed the result would be little less than chaos. It would be almost impossible to operate the railroads today without the multiplicity of time and labor saving electrical devices. These facts were plainly brought out in the discussions which took place at the semi-annual convention of the Association of Railway Electrical Engineers.

The attendance at the conventions was large and all of the exhibitors were busy in demonstrating their various products. The railroad electrical men were on hand early and the attendance at their convention exceeded that of any previous year at Atlantic City. The discussions which took place showed very decidedly that the electrical engineers are beginning to realize the importance of their work in the steam railroad field. Railroad operation today has become contingent upon the integrity of many and varied appliances using electrical energy. What is true of the present is certain to be greatly amplified in the future.

Letters to the Editor

Fifteen-Cell Batteries for Car Lighting

PHILADELPHIA, Pa.

To the Editor:

The editorial entitled "The Wrong Man Again" which appears in the June issue of the *Railway Electrical Engineer,* while expressing well-founded criticism of the lack of co-operation or even actual antagonism which occasionally exists between the mechanical and electrical departments of some railroads, presents the particular case used as a text in such an incomplete form as to be very misleading in regard to the results obtained with 15-cell car lighting batteries.

In the illustration used in this editorial, reference is made to the unsatisfactory results obtained by omitting one cell from the usual 16-cell car lighting battery. While it might be inferred that this was the only change that was made and that in all other respects the equipment was identical, and included lamp regulators in both cases, nevertheless this fact is not specifically brought out, and the casual reader is left with the impression that a 15-cell car lighting battery calls for special low voltage lamps. This, of course, is absolutely contrary to the facts, as there are many axle lighting equipments in service on some of the largest trunk line railroads using 15 cells of battery where the same standard lamps are used as with all other equipments on the system, and the illumination obtained has elicted especially favorable comments from the traveling public. These results have been due to the use of the constant voltage system and the omission of the lamp regulator.

To quote the words of the editorial above referred to. "Any electrical man knows" that the minimum drop of voltage in an ordinary lamp regulator in average operating condition will more than offset the voltage of one cell of battery, so that with an equipment which eliminates the lamp regulator, 15 cells of battery will give at least as good, and in most cases, better illumination than that obtained from an equipment requiring a lamp regulator with 16 cells of battery. The usual form of lamp regulator, consisting of a pile of carbon disks under more or less compression, is permanently connected between the battery and the lamps and introduces a loss of voltage which is always deducted from the battery voltage applied to the lamps. Equipments which do not require a lamp regulator eliminate this loss and permit the omission of one cell of battery.

The lamp regulator question may be briefly summarized as follows:

With equipments controlled for constant current and especially with batteries whose charging voltage is comparatively high, the lamp regulator is a necessary evil and introduces a number of objectionable features into the operation of the equipment. It introduces between the battery and the lamps a resistance which in the usual types of lamp regulator cannot be entirely cut out even when the battery is carrying the entire lamp load and the battery voltage has dropped to a comparatively low value.

Any resistance in the lamp circuit will cause a flicker at the lights when additional load is thrown on or off. This effect, of course, becomes greater when the equipment is in operation and the battery voltage is high, calling for considerable resistance in the lamp regulator. Furthermore, the lamp regulator is made up of parts having appreciable momentum and the vibration of the car acting on these parts will frequently produce flickering at the lamps.

The lamp regulator, composed of a series of carbon disks, is subject to deterioration due to the accummulation of dirt and cinders between the contact surfaces of these disks, resulting in unsatisfactory operation and abnormally high voltage drop when under maximum compression. The operation of the lamp regulator as ordinarily designed must be dampened by suitable dash pots and these are liable to deteriorate by wear and cease to function causing hunting and flickering of the lights, or on the other hand they may develop excessive friction and prevent the lamp regulator from responding to changes of voltage. These troubles can be reduced to a minimum by constant inspection and overhauling, but this means increased operating expense.

An axle lighting equipment operated by the constant voltage method and designed to actually maintain substantially constant voltage, permits the elimination of the lamp regulator by avoiding the high charging voltage characteristic of other methods of control. As stated above, the omission of the lamp regulator and the consequent elimination of the voltage drop in the carbon pile permits the omission of one cell of battery without lowering the minimum voltage applied to the lamps. By omitting this cell of battery the constant voltage which must be maintained in order to insure that the battery is properly charged is not too high for satisfactory results, either from the standpoint of illumination or lamp life. In proof of this statement it is not necessary to rely on academic arguments, as the system has been in service on so many axle lighting equipments for so long a period of time, that the results are thoroughly established by actual service records. What then is the excuse for considering the use of the lamp regulator in connection with constant voltage equipments? Its omission and the resulting reduction in the number of cells of the battery produce an appreciable reduction in the first cost of the equipment. To pay for an additional cell of battery and then purchase expensive apparatus to prevent the additional voltage thus obtained from being applied to the lamps with the resulting increase in maintenance and operating cost appears on the face of it quite illogical.

J. LESTER WOODBRIDGE,
Chief Engineer, The Electric Storage Battery Company.

[The writer of the editorial in an effort to show the need of good electrical men in railroad service, chose an example with which he was familiar to illustrate the point in question. The railroad which made the effort to operate with 15 cells of lead battery was using an equipment with a lamp regulator in which there was a minimum drop of about two volts. This fact was not mentioned and it was assumed that the electrical reader would understand that the effort was made to use 15 cells with equipment designed for 16 cells. It is true that some manufacturers of car lighting apparatus maintain that 16 cells are desirable under all circumstances and it is also true that others build equipments designed to operate with 15 cells and get results which to the users, the maintainers and the traveling public are highly satisfactory. Some of our readers may consider that Mr. Woodbridge's summary of the lamp regulator question is incomplete and in this case the *Railway Electrical Engineer* will be pleased to receive further comment.—EDITOR.

L. C. Hensel
President

E. S. M. Macnab
1st Vice-President

E. Lunn
2nd Vice-President

J. A. Andreucetti
Secretary-Treasurer

Railway Electrical Men Meet in Atlantic City

Semi-Annual Convention Draws Large Attendance and Much Interest is Shown in Progress Reports

THE semi-annual meeting of the Association of Railway Electrical Engineers, held at the Hotel Dennis, Atlantic City, N.J., was called to order at 10.10 a.m., by E. S. M. MacNab, first vice-president of the association, in the absence of the president, L. C. Hensel. In presenting the opening address Mr. MacNab spoke as follows:

"I am glad to welcome you to this semi-annual convention of the Association of Railway Electrical Engineers, and to see such a good attendance of members.

"I must first apologize for the absence of our president, L. C. Hensel. Those of us who know him, I am sure, agree that it is most urgent business which prevents him being with us to-day, as he has always been most attentive both at convention and executive committee meetings.

"This is the first semi-annual meeting which has been held for two years owing to depressed business conditions. However, I feel confident that we have passed the lowest point on the curve and that the near future will restore the normal flow of business which is essential for the prosperity of the railways and the country in general. The railway equipment purchases during the past five months, as shown in the *Railway Electrical Engineer,* were as follows: Passenger cars, 1,195; freight cars, 77,053; locomotives, 460. These figures would bear out this contention.

"There will be presented for your consideration and discussion, progress reports from several committees and I would ask that we have a very full discussion, and if any member has any data or information which he can bring out it will materially assist the several committees and at the same time make their reports more complete.

"We will also be favored by having a paper on 'Industrial Heating' read to us by B. F. Collins, of the General Electric Company, which I am sure will be both interesting and instructive. It is a subject that has come to the front of late and this paper will constitute a valuable addition to the proceedings of the association.

"In closing, it is hardly necessary to draw attention to the splendid collection of exhibits on the pier. I often think that we do not sufficiently appreciate the advantages we have by being able to inspect the latest additions in all the branches of the railway mechanical engineering field, and I am safe in saying that in no other part of the world, would it be possible to duplicate this A. R. A. convention."

Progress Reports Presented

Immediately following the opening address the progress reports of the several committees were presented and discussed. All of these reports were printed in the June issue of the *Railway Electrical Engineer* with the exception of two—namely—Train Lighting and Locomotive Headlights and Classification Lamps. These last two reports are in reality considerably more than progress reports. They are printed here in full immediately following the discussion of the other reports.

* * *

Discussion of Data and Information Report

E. A. LUNDY (Railway Electrical Engineer): Gentlemen, there is one thought that I have had in connection with this Data and Information work, which is that it is not only going to give us some very valuable records but it is going to furnish some information that will make possible to show the things the railroads are doing electrically.

CHAIRMAN MACNAB: Gentlemen, are there any points or questions you would like to ask Mr. Lundy, or any suggestions you would like to make now, so that the full report of the October Convention will be as complete as possible?

J. R. SLOAN (Pennsylvania System): I would like to make a suggestion to the Committee, that inasmuch as for a number of years back, we have been collecting this data and information, it might be of interest to plot curves showing the tendencies, showing the increases and decreases of the various items going along through the various years.

E. WANAMAKER (Electrical Engineer, Chicago, Rock

Island & Pacific): I would like to suggest that it might prove of some personal benefit to the electrical fraternity, including the railroad men and the manufacturers, if some value was placed on the electrical equipment that is now used; that is, to what extent; how much money has been invested, and of what primary importance is the electrical installation. I think that this is a very good time to include such things.

We all know that on the majority of the railroads today, that if the electrical equipment fails to function, you won't run very long.

CHAIRMAN MACNAB: Gentlemen, Mr. Wanamaker's idea is certainly a good one. I like very much to question how far we would be able to get with it. I do not know what the Committee, Mr. Lundy, thinks of the idea, but in the past, we have always had a great difficulty in getting figures together for this Data and Information Committee.

SECRETARY ANDREUCETTI: Mr. Chairman, the trouble of getting figures, is due to the fact that railroads have not them available. In most cases they were glad to give figures, but in my contact with the greatest number of railroads, I find that they do not begin to have any data at all on costs.

L. D. MOORE (Missouri Pacific): While it is probably quite true that there would be difficulty in obtaining operating and maintenance costs which would be reliable, I believe the Committee itself would probably be familiar enough with the average costs of equipment in service.

MR. SLOAN: Talking of this subject, the most important feature of it, to my mind, is the fact of that which would happen if we shut down the electrical end. Take, for instance, our baggage handling, how could we get along without baggage trucks in our freight houses? How could we get along without the tractors in our round houses; what would we do if the main electrical generators went out of business? The whole shop would shut down. That is the point I think the Committee ought to bring out.

E. W. JANSEN (Electrical Engineer I. C. R. R.): I agree with Mr. Wanamaker and Mr. Sloan, we ought to get this data together. I would estimate roughly that possibly one and a half per cent of the value of any modern road is represented in electrical equipment, and that runs in the average large system from three million dollars to five million dollars, and it is worth bringing to the attention of the management.

Discussion of Motor Specifications

CHAIRMAN MACNAB: Gentlemen, the next Committee report we have before us this morning is the Progress Report of the Committee on Motor Specifications, and I will ask Mr. Wanamaker to read the report.

* * *

MR. WANAMAKER: One of the items which by the way was not minor, was the sparkless commutation in direct current motors. I might say that since this progress report was made, tentative motor specifications have been completed.

This specification covers motors, a. c. and d. c., open type, from one horse-power, 1,800 r. p. m. to 75 horse-power, 900 r. p. m., that is, for the standard rating, and then on a percentage basis the intermittent duty motors are also covered.

It is thought that possibly next year, if the Committee is continued, that they will be able to draw up specifications for mill type motors and crane motors and for the various controls that are used.

Our investigation showed briefly that failures of insulations and failure of bearings were the two things on which depend the life of the motor.

* * *

Discussion of Illumination Report

L. S. BILLAU (Asst. Electrical Engineer, B. & O.): In the present progress report, the first section only had been covered. The only feature of interest to draw attention to is that a comparatively large number of incandescent lamps are being used in train lighting service. It seems in line with the general practice today to reduce the number of kinds of items, material in use on a railroad, that more serious effort should be given towards standardizing upon a few number of types of lamps in railroad use; and in that connection the Committee has recommended certain ranges of sizes and types of lamps as recommended standards.

Attention is also drawn to the fact that the mazda C lamp is now available in 25 watt size, and your Committee recommends the use of that lamp, particularly where that sized lamp is used for general illumination purposes.

G. W. BEBOUT (Chesapeake & Ohio): At the last meeting in Chicago, in our Convention, I mentioned the fact that we were trying the mazda C mill type of lamp that had been developed, and we were using it in place of the 60-watt carbon lamp. We have since established that as our standard for portable lighting, the 25-watt lamp is much more rugged than the old carbon lamp, uses less current and is a very much better lamp.

SECRETARY ANDREUCETTI: Mr. Chairman, I am not questioning Mr. Bebout's contention as to the efficiency of the lamps, but I have got to question as to the lighting and durability of them on extension work. My experience has been just the reverse, even with the present improved mill type lamp, we have not found it possible to get any life out of that at all. There is too much breakage. I dare say the breakage is five times greater than with the carbon lamps.

MR. JANSEN: What type lamp is that you say?

MR. BEBOUT: The Westinghouse type C mill type tipless lamp.

MR. JANSEN: Carbon lamps, I think you will get around 11 or 12 C. Our experience was that we use probably as many as five times of those lamps as carbon lamps.

MR. WANAMAKER: Mr. Chairman, just recently we started using the mill type lamp, and it looks pretty good so far. We tried it a little over two years ago, and it did not stand up. But I got some a few months ago, and they seem to be standing up equally as well as the carbon lamps.

MR. MOORE: I just wonder whether it will be within the province of this Committee to investigate the matter of electric-train lanterns. I asked Mr. Wanamaker about some he had been using, and he had not completed his tests.

MR. WANAMAKER: We have completed them now, and if you will write again, I will send you some information.

CHAIRMAN MACNAB: Mr. Bender, there has been a little discussion here as to the use of the mill type C 25-

watt lamp for portable extensions, and several of the members present here have tried them with good results, and we have had several who have had the reverse. I think the meeting would be glad if you would give them a few words, or say a little on the subject and perhaps it may help to clear the proposition up for a portable lamp.

Mr. Bender: I do not know, Mr. Chairman, that there is very much that I can say on that, except that we have a great many reports of tests on the mill type lamp, and it has been very, very satisfactory. The lamp is a very much better lamp today than it was a couple of years ago; but the fact remains that in some places, they do not work out, whether it is owing to the way the men handle them or there is something peculiar about the shop, that we are not prepared to say.

Mr. Jansen: Just what type of mill type lamp, what wattage and type of bulb?

Mr. Stover (National Lamp Association): Mr. Chairman, we make two wattages in our present mill construction, that is 25 and 50 watt in the 110 volt class, and 50 watt in the 220 volt class, and they are designated P-19 and C-9. We do not make the old type any more, which was with the straight filament, with the supports in the center. The coil filament supersedes it, and is very much better mechanically, and it will stand up very much better.

Mr. Jansen: Do you know what they cost, the average?

Mr. Stover: The list price of that lamp, as I recall it, is 40 cents.

Mr. Jansen: What do you think ought to be the average life of 230 volt, 220 volt, and with equipment of same as a standard railroad lamp?

Mr. Stover: They are designed for a 500-hour life, which would be as much as you would get under uniform voltage conditions, and possible without any very great shock.

Mr. Jansen: Have any of the members any data on the average they got on that, the number of engine service hours per month?

Mr. F. J. Hill (Michigan Central): The average on Michigan Central head light lamps is about 350 hours, and on cab lamps, it runs about 1,300 hours.

Mr. McGuinness (Pyle National): About the life of a 32-volt 250 watt lamp, that is naturally interesting us a good deal, and on a road having 125 locomotives, which is a transfer switch road, where the engines can pretty well be watched, we have been attempting for about a little over three months to get some estimate on the life of the head light lamp. Up to date, if we would take the total number of lamps purchased, and divide them by the number of hours that the locomotive is supposed to be on night service, we get about 320 burning hours. If we take the lamps applied to the locomotive, and in this case there are two lamps to the locomotive, 250 watt, 32 volts, and watch those engines, and check carefully their burning hours, it averages 18, and if the engines were in service every day, it would probably be 24, but they go to the round houses for washouts and certain repairs, which cuts it down to about 18 hours, the average, we get there a little over 500 burning hours in three months. I think the last check we made, which was about a month ago, ranged about between 320 to 520 burning hours. Now, those two figures are very widely apart, and it would indicate that there is considerable breakage, or losses at least, between the number of lamps purchased and the number of lamps that actually are giving service. But based on the first two months, we plotted some curves or figures rather which are in the hands of the electrical men, the Master Mechanic and ourselves, and three of us are making checks on that to try to determine just what the percentage loss on lamps is, due to actual burning out; what percentage due to breakage and pilfering, and other losses, and to get some accurate figure; and I might say that this would represent a pretty fair service, because it is on switching and transfer service, where you would expect to get the maximum of shock; but the way it stands now, it is a little difference between 300 and 500 hours.

* * *

Discussion of Electric Welding

E. Wanamaker: Your Committee on Electric Welding, with Mr. Pennington of the Chicago, Rock Island and Pacific Railroad as Chairman, have been working for the past year on what I presume is the first specification for electric arc welding equipment. This specification was drawn, we might say, a step at a time, somewhat similar to the motor specification, it started out with a specification of a single operator direct current arc welding generator set, as the great majority of equipments now in use are of that type. There are some changes which have been made since this specification was submitted.

I might say that this specification was drawn with a great deal of difficulty. It is a new art, and there are just about as many different ideas as there are people producing welders, plus some ideas of people who are using welders, which do not entirely agree with any of the manufacturers.

However, after about five months of continual effort, meeting every month and sometimes two, this specification was evolved, and everybody voted for it unanimously, and we feel that while everybody did vote for it unanimously, there is nothing which has been given up: That is to meet the demands of rank commercializing; so we are going to leave the report with you for what it is worth.

Chairman MacNab: Gentlemen, the report of the Committee on Electric Welding, is now open for discussion and if any one person wishes to make any suggestion or ask any question on the subject, we would be glad to hear from them. As no one seems inclined to question Mr. Wanamaker's specification and his work, we will call on Mr. Lawrence C. Bowes, inspector of Stationary Power Plants, of the C. R. I. & P. R. R. to read the report on Stationary Power Plants.

* * *

Discussion of Stationary Power Plants

Mr. Bowes: Your Committee at this time has no full report to give. It is merely a report of the progress or rather an outline of the work they intend to take up and submit in a final report next October.

It is the intention of the Committee this year to go a little more in detail, an elaboration of its former report and to attempt to establish a standard basis of estimating and calculating the proper distribution and charges of facilities served by railway stationary plants.

Chairman MacNab: Gentlemen, the paper is now open for discussion. I think the point brought up by

Mr. Bowes as regards charging various departments with their proportion of the cost of the operation of the power plants is a good one, simply on the commonsense basis of anything that anyone gets for nothing is not appreciated.

Mr. Moore: I just wondered if Mr. Bowes' Committee contemplated in this distribution of cost that they are figuring including a method by a list of items to be included in power plant cost. It has been pretty hard to know or get from the other departments the exact costs and the accurate costs of our power plant operation.

Mr. Bowes: It is the intention of the Committee to outline briefly what the cost of operation should consist of. Now, we believe that it should be labor and material, as it is very difficult to figure in interest and depreciation in a monthly cost of operation.

C. H. Quinn (Norfolk & Western Railway): Mr. Chairman, about 15 years I have been following this subject rather closely, and I find that the use of steam flow meters, either of the portable or stationary type, with a sufficient number of nozzles, so that you can check up the several circuits furnishing steam, either from the roundhouse heating, necessarily is a very excellent check.

Air-compressors are checked up on the basis of revolution counts.

* * *

Discussion of Electric Repair Facilities and Equipment

Mr. Quinn: As a matter of information, it may help some of the members of the organization in working out some accounting details connected with this phase of motors, I do not know how it is on other railroads, but if the equipment is transferred from one terminal to another, it is very important that the Valuation Department have an exact record of the progress of the equipment and the original purchase price, and one thing and another.

To take care of that, on the Norfolk and Western, we have developed this system of numbering that, which gives the year in which the apparatus was purchased and the month in which it was purchased, and also the serial number of the purchase during that particular year. That gives you the number on the motor of seven figures; but regardless of where a motor happens to be placed, anyone can go up there and check up immediately the date of purchase, and go right back and get the original copy of the Purchasing Agent's order.

I do not know whether that will be of any particular assistance to other members of the organization, but we have found it of tremendous value in checking up apparatus that workmen would check out of one road house and shift to another, or without saying anything to anyone, or taking it from one shop building and putting it over into another. It also, as I say, helps out very materially on our index card system.

Chairman NacNab: Gentlemen, if there is no further discussion on the paper, we will pass on to the next subject, and that is the Committee on Power Tractors and Trucks. I will call on Mr. Moore to read the report.

* * *

Discussion of Power Trucks and Tractors

Mr. Moore: I am not going to read this report, as it is published here, as our time is getting short. I just want to say that our report in the fall will cover the general applications of industrial power trucks and tractors, and specific applications with a sort of application table, so that it will be easy to refer to this table and tell what class of equipment can be used in each class of service.

Mr. Bowes: Mr. Chairman, on a point of information, we recently fixed up in a general way, the comparison of electric and gasolene tractors, and we have asked the advice of our Insurance Department.

Chairman MacNab: I would say, gentlemen, that in shops which cover a rather wide area, and with regard to which we have rather a difficult transportation question in the winter, due to the amount of snow, that we use gasolene tractors, a couple of them for more or less long distance hauls, that takes material from one end of the plant to the other, and means considerable out-door haul. We have a large fleet of storage battery trucks which operate in the store shops and more or less indoors. We also keep a couple of gasolene tractors which we handle on the outside, especially in winter time, when we have a rather deep snow there.

Mr. Billau: I would like to emphasize this question of a gasolene truck in comparison with the electric truck. The recent development of the gasolene truck and tractors of the industrial type, operated in competition with the same character of competition as the electric service trucks, make the subject one of vital importance; and while I think that each type of truck has a legitimate field of operation, there is very little reliable data available today on costs of operation and maintenance, reliability, and so forth, on which to base our quotations or conclusions, as to where the two best fit in; and I know of no information that would be of greater value to the railroads than any reliable data that can be obtained for the benefit of railroad men of these two types of trucks in shop service.

* * *

Discussion of Train Lighting and Equipment

Mr. Billau: Mr. Chairman and Gentlemen, this report is rather descriptive in character, and I will not attempt to abstract it, but will leave the time available for discussion.

It is rather interesting at least to me, that when you realize the question of direct driving axle generators has always been one of the most difficult and troublesome and probably expensive parts of operation and maintenance of train lighting, and that the subject has not received as intensive study, either possibly by the railroads or from the Association as it has during the past year or so, and I feel that particularly this question of the direct drive, is about the first opportunity or the first time that it has really been seriously brought before Railway Associations for active consideration.

Chairman MacNab: Gentlemen, this is a very live subject to this Association at the present time, and several manufacturers have worked on this question of direct mechanical drive; and I suppose the Northern Railroads, of which the Canadian Pacific is one, have been more or less responsible for considerable agitation along these lines.

We developed a drive ourselves on the Canadian Pacific and tried it out during last August, up to a month ago, it developed some inherent defects which rendered it necessary to stop the car about every four thousand miles.

On the question of the broad axle pulley, I would like to hear what the results have been up to date on the Pullman.

Mr. Sloan: With regard to the wide-faced pulley, the Pullman Company adopted an experiment a week ago last Friday, to which they invited quite a number of railroad men, and I was among those present. This was the test of its value on a 247 foot radius curve, and they told us that with no other pulley that they had ever tested, could they keep the belt on going around that curve. This pulley was 18 inches in diameter at the middle, tapering to 16 inches at the end. It was 28½ inches long, and had an inch and a quarter flanges. We juggled the car back and forth on this curve, and at the point at which the part was furthest from the center, we still had an inch and five-eighths to go before the belt hit the flange. It took 18 minutes to put on the axle bushing and it took five minutes to remove it, two men working. The pulley itself weighed about 270 pounds. Of course, they were fixed up with some special tools that they developed to assist in the operation.

C. W. T. Stuart (Pennsylvania): I would like to ask what kind of generator was used with this axle pulley, what style of generator pulley in this test.

Mr. Sloan: I did not notice anything special about the axle generator to the pulley. It seemed to me it was about an 8 inch pulley with ordinary crown and flanges.

Chairman MacNab: Gentlemen, the time is running on. We will close the discussion on this Committee report, and take up the Committee on Locomotive Headlights and Classification Lamps; and I will call on Mr. Mulheim, of the Baltimore & Ohio.

* * *

Discussion of Headlights and Classification Lamps

Chairman MacNab: Gentlemen, is there anyone who has any question to raise on this Committee report? We will be glad to hear from them. I suppose and presume it is the intention to issue the report in full at the October convention?

Mr. Mulheim: Yes.

Mr. Haylor: I do not know if anyone here was present at the discussion of this paper at the A. R. A. Committee; but I would like to say that they had a very lengthy discussion of the subject over there until they came to the discussion of parts which were purely electrical; when there was an evident need for some of you people over there; and the part under discussion at which they got stumped, had to do with voltage rating on headlight lamps.

The claim was made that it was wrong to change the voltage rating from 34 to 33 volts. That it resulted in a loss of many cab lamps. And the statement that was made was wrong and it was discussed pro and con, but no one came to any definite conclusion; and I think that it might be advisable for someone who knows the subject thoroughly, to present it, so that when the two discussions are combined, there will no longer be any question in the minds of the people interested.

Mr. Bouche (Gold Couple Co.): I would like to ask one question, when that point comes up again; and I think I can put it in a different light than Mr. Hill expressed it before. And I think it is the way to put it to any electrical men present if it ever comes up for discussion among the railroads; and that is this: What percentage of variation on the voltage will in no wise affect the life of the lamp? Mr. Bender, I think you can answer that?

Mr. Bender: I would say nothing. Any variation in voltage would affect the life of your lamps.

Mr. Bouche: I mean radically speaking. Say with reference to that class of lamp, with 500 recording hours. Say we varied it two per cent; we would just depart by two per cent plus or minus. What effect would it have on the light?

Mr. Bender: That is different. I would say nothing. Any variation in voltage would affect the life of your lamps. I have not got the table with me. Possibly Mr. Silver can answer it. Possibly five per cent.

Mr. Bouche: Then I cannot agree with the lamp maker. I have run variations. One locomotive does nothing else but switching. That locomotive runs day and night and our light variation is from 32 to 34, according to the load on it, and the life of our lamps have anything beat that I have heard here, gentlemen. We have done 750 to 900 burning hours.

Mr. McGuiness: I should have added a while ago, when we were talking about lamp light, that there is a little road, a mountain road, that has only seventy-two locomotives that handles transfer services in the twin cities, that is getting from their own statement, from fifteen to twenty-three hundred burning hours out of their headlight lamps. Now, when the Master Mechanic, who is the officer in charge in that case and keeps very close track of whatever is bought and used, will tell you that, and there is no one to gainsay it, that shows the great range of difference in burning hours.

Mr. Sloan: The gentleman was asking how much the life would be changed by an excess of voltage, and he received his answer. On the other hand, if you run an under-voltage, you are going to have an increase in life. It is perfectly possible you may be running these lamps and these extraordinary lives are obtained from a 34 volt lamp and a 32 volt generator. You cannot look at only one end of the subject.

Chairman MacNab: Mr. Wanamaker, do you want to say anything?

Mr. Wanamaker: I think I said once before that probably the care we take of the generator that holds the voltage down is the most important factor of all. I know we discovered that on our road. We never complained about the lamps as long as we kept the bases from twisting off. That is about our only complaint so far as the lamp is concerned.

The point I want to bring up was as to the holding of this session at Atlantic City at an hour that did not conflict with that which is held over on the pier. It has worked a hardship on me every time I have been down here. I should have been over there, but loyalty to the electrical engineers brings me over here; and I might suggest, if I may be pardoned, that the air brake convention is vitally interested in connection with the Electrical Railway Engineers in the subject of automatic train control.

There is a certain proposition which only concerns the signal department, with that part which goes into the roadway; and if I may be pardoned for saying it, the vital part of train control is the locomotive force which belong to the mechanical department and which is being handed in turn down to the Railway Electrical Engineers; and I know that the airbrake people feel that it is necessary for them to work very closely in conjunction with

our Association on that subject, which is fast becoming a very vital and very important one. *

Gentlemen, this concludes the business of this semi-annual Convention, and I want to thank the members present for the large turn-out that we had this morning.

I think the Association is to be congratulated that it is on the job and thoroughly alive, and I hope that each and every one of you will have a very pleasant stay here in Atlantic City, and derive considerable benefit from not only our meeting here this morning, but from the various exhibits that are on the Million Dollar Pier.

REPORT OF COMMITTEE ON LOCOMOTIVE HEADLIGHTS AND CLASSIFICATION LAMPS

COMMITTEE:

W. H. Flynn (chairman), superintendent motive power, Michigan Central Railway; C. H. Rae, assistant superintendent machinery, Louisville & Nashville Railroad; A. R. Ayers, superintendent motive power, New York, Chicago & St. Louis Railroad; H. M. Curry, general mechanical superintendent, Northern Pacific Railway; J. L. Minick, assistant engineer, Pennsylvania System; E. W. Jansen, electrical engineer, Illinois Central Railway; R. W. Anderson, superintendent motive power, Chicago, Milwaukee & St. Paul Railway.

TO THE MEMBERS:

Approval of the plan to work jointly with manufacturers of headlight turbo-generators and the Association of Railway Electrical Engineers in developing certain standard practices was given your committee at the 1920 convention, and in addition it was found advisable to include manufacturers of ball bearings, hearty co-operation and valuable assistance being received from all.

The resulting recommendations for each of the subjects referred for development with additional recommendations for brush holders and spacing of bolt holes in base of headlamp cases are herein submitted for your consideration, it being understood, where the recommendations necessitate redesigning, that they will apply to future construction only.

The lack of uniformity in number as well as location of supports or feet on the various makes and types of turbo-generators which is illustrated in Fig. 1 renders interchange difficult, and is detrimental to the best interests of manufacturers as well as objectionable to the railroads. The spacing recommended can be adapted to future designs without much difficulty, thus overcoming the present chaotic situation.

The recommendation for the location of the steam inlet may appear to allow the manufacturer more latitude than is desirable but to fix a definite location appeared to be an unnecessary handicap in the freedom of design. With the variation in location of steam inlet from the longitudinal and transverse center line of bolt spacing and vertically above the base plate in increments of one-half inch, any make of turbo-generator can be applied without the necessity of changing the steam pipe from the boiler by using standard fittings and proper lengths of pipe nipples, standard lengths of which vary by one-half inch increments.

The restriction of turbo-generator manufacturers to one size of ball bearing was likewise considered as unnecessarily hampering future development and particularly with reference to the design of the shaft. Much of the ball bearing trouble that is being experienced can be attributed to

1. Rotating parts out of balance.
2. Shaft running near the critical speed, producing excessive vibration.
3. Shaft loose in bearings which, when existing, rapidly increases.
4. Shaft too small which, when attachments thereto are out of balance, springs out of line to seek its balance, thus throwing bearings out of alinement.
5. Faulty design of bearing housing, which permits dirt to work into bearings. This condition is aggravated by centrifugal action of revolving parts, creating a tendency to discharge air through all possible outside openings and draw in air near center of shaft carrying dirt with it.

Shafts of larger diameter with a higher critical speed are less liable to distortion on account of parts out of balance, and with a range of the following three sizes of ball bearings (the principal dimensions being given in inches) which the ball bearing manufacturers agreed could be expected to give satisfactory results, a greater opportunity is afforded the designer to overcome the difficulties enumerated than would be the case if he were restricted to one size of bearing.

Bearing Number	Outside Diameter (Base of Housing)	Inside Diameter (Diam. of Shaft)	Width of Race	Size of Ball
306	2.8347	1.1811	.748	7/16
308	3.5433	1.5748	.9055	9/16
406	3.5433	1.1811	.9055	11/16

NOTE.—The size of ball refers to one make only but other makes will not be greatly different.

A method of overcoming the possibility of dirt working into bearings is a problem yet to be worked out by the designers of turbo-generators, and in this connection suggestion has been made that some form of air inlet near the center of the shaft be provided in such a way that the incoming air would not pass through the bearings, also that a pressed steel disc carried by the shaft running close to a pressed steel disc carried by the housing would soon fill with grease and form an effective dirt seal.

Experience has demonstrated that oil is best for lubrication. It should be as light as possible, consistent with the conditions of heat under which it operates, but not so light that there will be excessive evaporation. The best results will be obtained if the oil is filtered and kept in a covered receptacle.

The bolt spacing for base of headlamp cases, while not one of the subjects originally referred to this committee, was considered advisable to standardize if possible and it is believed that the recommended spacing, 12½ in. crosswise by 12 in. lengthwise, see Fig. 2, can be readily adapted to all designs. Where a railroad's standard location for headlamp is on the top or near the top of smoke box, and the recommended bolt spacing will bring the top of the headlight casing above clearance limits, the transverse spacing of bolt holes can be changed to 14 inches, but as there are so few railroads where this condition exists, it was not considered necessary to cover this condition in the recommendation, it being believed advisable to leave the matter to the railroads affected to arrange with the manufacturers.

In this committee's report to the 1920 convention, reference was made to headlight reflectors that were being developed which would not require as constant attention

*The paper on Electric Heating by E. F. Collins and the discussion pertaining thereto will be found in the August issue of the *Railway Electrical Engineer.*

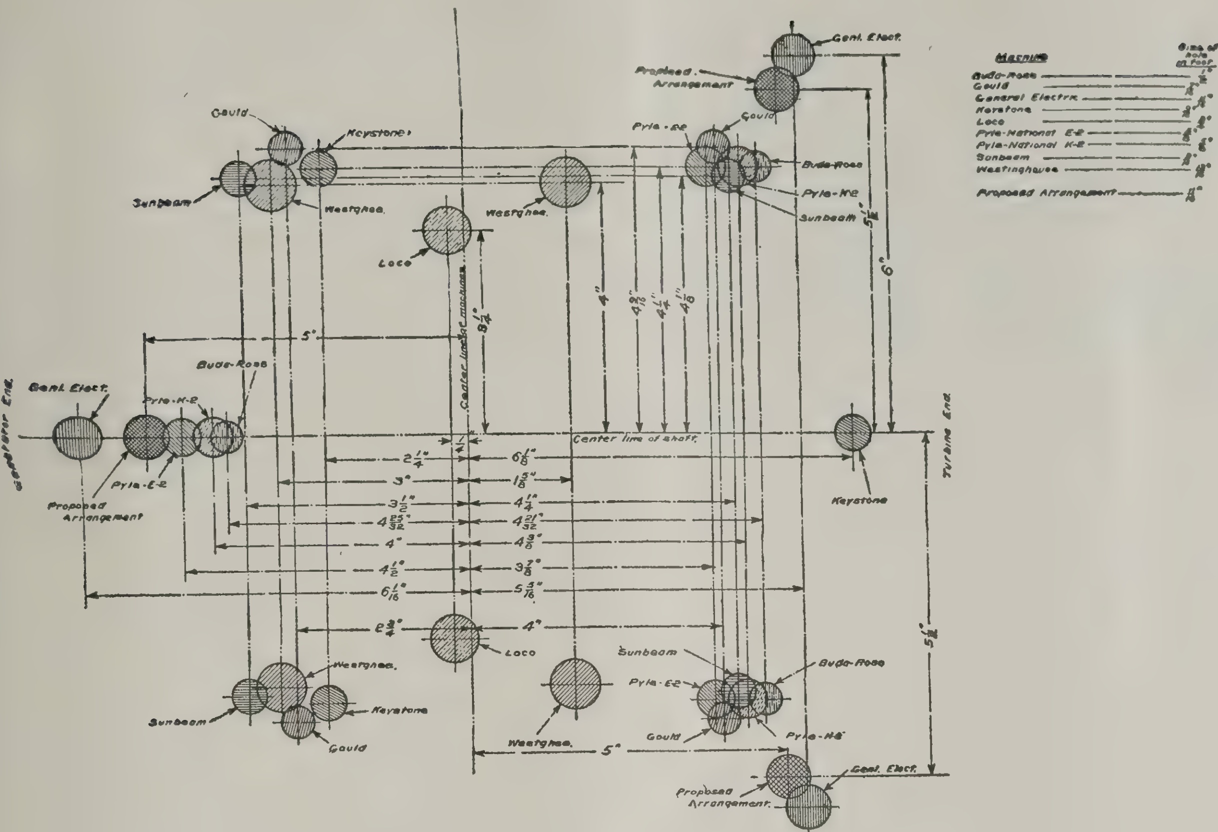
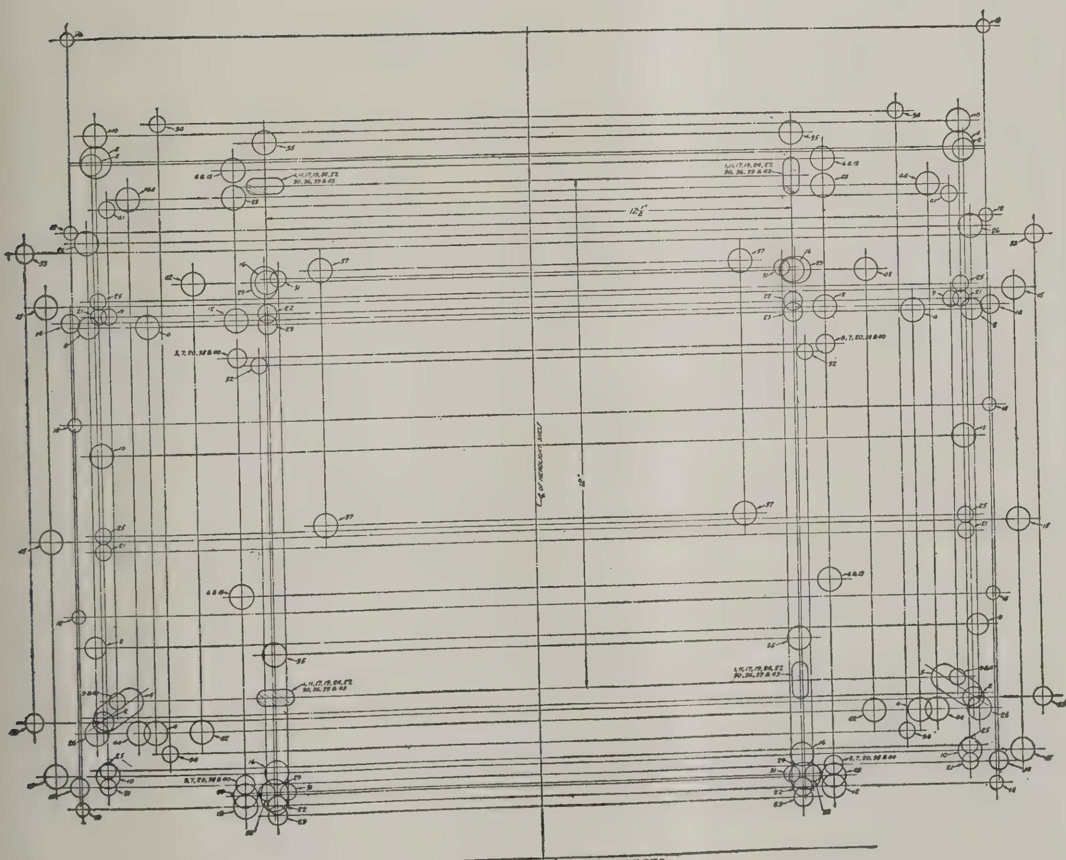


Fig. 1—Location of Supports on Turbo Generators



NO.	RAILROAD	REMARKS
1	MICHIGAN CENTRAL	STANDARD FOR ELECTRIC
2	MICHIGAN CENTRAL	OIL & CONVERTED
3	N.Y.C.R.R. & M.C.R.R.	U.S.R.A. 2-8-2 & 0-8-0 TYPES
4	NEW YORK CENTRAL	STD. FOR 6" HEADLIGHTS
5	NEW YORK CENTRAL	STD. FOR 9" HEADLIGHTS LOCATED ON TOP OF SMOKE BOX
6	NEW YORK CENTRAL	STANDARD FOR ELECTRIC
7	NORTHERN PACIFIC	U.S.R.A. LOCOMOTIVES
8	NORTHERN PACIFIC	STANDARD
9	MISSOURI, KANSAS & TEXAS	MIKADO TYPE
10	MISSOURI, KANSAS & TEXAS	PACIFIC TYPE
11	LEHIGH VALLEY	STANDARD
12	LOUISVILLE & NASHVILLE	FOR SCHROEDER HEADLIGHT
13	ERIE	STANDARD
14	GRAND TRUNK	STD. FOR ENGINES WITH CYLINDERS 19 AND OVER EXCEPT CLASS F
15	CHICAGO & NORTHWESTERN	STANDARD
16	WABASH	STANDARD
17	PERE MARQUETTE	STANDARD
18	PENNSYLVANIA	CONVERTED OIL HEADLIGHTS
19	NEW YORK, NEW HAVEN & HART'D	STANDARD
20	NEW YORK, NEW HAVEN & HART'D.	U.S.R.A. LOCOMOTIVES
21	SOUTHERN PACIFIC	STANDARD
22	TEXAS & PACIFIC	STANDARD (ON FRONT END)
23	TEXAS & PACIFIC	STANDARD (TOP OF SMOKE BOX)
24	DELAWARE & HUDSON	STANDARD
25	UNION PACIFIC	STANDARD
26	SANTA FE	STANDARD
27	BESSEMER & LAKE ERIE	STANDARD
28	BUFFALO, ROCHESTER & PITTSBURG	STANDARD (EXCEPT ON MALLETS)
29	CHICAGO, MILWAUKEE & ST. PAUL	STANDARD
30	CENTRAL OF GEORGIA	STANDARD
31	C.R.R. OF NEW JERSEY	PYLE NATIONAL & GLAZIER 18"
32	C.R.R. OF NEW JERSEY	DRESSEL 18"
33	CHICAGO, BURLINGTON & QUINCY	STANDARD
34	CANADIAN PACIFIC	STANDARD
35	CANADIAN PACIFIC	STANDARD
36	D. L. & W.	STANDARD
37	NORFOLK & WESTERN	STANDARD (ON FRONT END)
38	RUTLAND	STANDARD
39	DELAWARE & HUDSON	STANDARD (PYLE-NATIONAL)
40	DELAWARE & HUDSON	STANDARD (SCHROEDER)
41	ILLINOIS CENTRAL	STANDARD
42	BALTIMORE & OHIO	STANDARD
43	BOSTON & ALBANY	STANDARD
44	CHICAGO, ROCK ISLAND & PACIFIC	STANDARD
	GREAT NORTHERN	NO DRAWINGS
	VIRGINIAN	NO DRAWINGS
	ST. LOUIS & SAN FRANCISCO	NO DRAWINGS
	ATLANTA & WEST POINT	NO DRAWINGS
	CHICAGO & ALTON	NO DRAWINGS
	CANADIAN NATIONAL	NO DRAWINGS
	SOUTHERN RAILWAY	HOLES LOCATED TO SUIT
	CHICAGO GREAT WESTERN	HOLES LOCATED TO SUIT
	NICKEL PLATE (N.Y.C. & St.L.)	NO STANDARD
	ATLANTIC COAST LINE	NO STANDARD

Fig. 2—Bolt Spacing for Base of Headlamp Cases

to keep clean as is the case with the silver-plated copper reflector, a large number of such reflectors of crystal and uranium glass with silvered backs and varying in diameter from 12 inches to 16 inches, the size most commonly used being 14 inches, have been in service a sufficient length of time to demonstrate the permanency of their reflecting value, and small expense of cleaning.

From information received of tests that have been conducted, there seems to be no doubt that these reflectors used in conjunction with lamps which have been adopted as standard will produce ample illumination to meet the requirements of the Division of Locomotive Inspection of the Interstate Commerce Commission, but in the absence of what might be termed official tests it is not considered advisable to present any recommendations at this time.

Consideration has been given to the advisability of using cab lamps of smaller dimensions, with the idea of reducing the size of lamp cases and the lamp manufacturers are co-operating in an endeavor to produce a satisfactory 15-watt S-14, 33 volt lamp to be used in place of the present S-17 lamp, but the development has not advanced sufficiently to warrant other than mention. The S-14 lamp is approximately 11/16 inch shorter and ⅜ inch smaller in diameter than the S-17 lamp.

A number of new and commendable styles of headlamp cases have been developed by the manufacturers since the last convention, lightness of weight, coupled with durability, being the dominant features, although other noteworthy refinements have been accomplished. However, your committee has not thought it advisable to consider their standardization other than with respect to the bolt spacing of the base.

There will be found at the end of this report several recommendations for maintenance practice for your consideration, and, while the recommendations submitted at this time are few, it is hoped that the start that has been made will eventually result in the formulation of a set of maintenance regulations which will be of assistance to the railroads in obtaining best possible results from the electric lighting equipment on locomotives.

Your committee would recommend the following be submitted to letter ballot as recommended practice for future designs, and to be added to recommended practices.

1. Turbo-generators to have three feet for support and attachment to base plate, thickness of feet at bolt hole to be ¾ inch and ribbed on sides to engage head of bolt to prevent turning, ribs to extend to body of generator to strengthen the feet, holes in feet to be 11/16-inch diameter for ⅝-inch bolts, bolts to enter from the top with nuts on under side of base plate. Bolt hole spacing to provide for one bolt at generator end on longitudinal center line of machine 5 inches from transverse center line and two holes at turbine end on opposite sides 5½ inches from longitudinal center line and 5 inches from transverse center line.

Where clearance between foot and body of generator prevents entering bolt from top, foot may be slotted, but where it is necessary to slot all feet slot in foot at generator end should be parallel with longitudinal center line and slot in feet at turbine end parallel with transverse center line.

2. Steam inlet of turbo-generator to be for ½-inch iron pipe, exhaust outlet to be for 2-inch iron pipe and drain to be for ½-inch iron pipe.

3. The variation in location of steam inlet from longitudinal and transverse center lines of bolt spacing, and the distance above the base plate to be in increments of ½ inch, steam inlet to be on left side facing turbine end.

4. Ball bearings to be any of the following numbers, which also designate the size:

No. 306 No. 308 No. 406

5. Brushes to be 1 inch wide, ½ inch thick and not less than 1½ inches long.

6. Brush holders to be equipped with springs so designed that no adjustment is necessary or possible during the full life of brush and commutator and to provide uniform pressure during 1-inch wear of brush. Brush holders to be machined inside, set 3/32 inch from commutator and at an angle of 10 degrees.

7. Bolt spacing for base of headlight casings to be 12 inches by 12½ inches, the center line of back holes to be not more than 5 inches ahead of rear of case, bolt holes to be 7/16-inch diameter for ⅜-inch bolts, general design of casing to permit bolts to be applied from top with nuts on under side of bracket.

8. Screw sizes smaller than No. 12-28 thread not to be used, heads to be either fillister or flat and material to be brass or steel. For sizes larger than No. 12 use ¼-inch—5/16-inch—⅜-inch, etc., bolt sizes, heads of ¼-inch and 5/16-inch bolts to be slotted to permit use of screwdriver.

9. Lubrication for turbo-generators to be oil.

Your committee also recommends the following be submitted to letter ballot as recommended practice for maintenance of turbo-generators:

1. Oil for lubrication to be as light as possible consistent with the conditions of heat under which used, to be filtered before using and kept in a covered receptacle.

2. Oil reservoirs to be kept free from accumulation of grit and dirt.

3. Extensive repairs and particularly repairs to rotating parts to be done only at shops or designated points where adequate facilities are available.

Respectfully submitted,

COMMITTEE ON LOCOMOTIVE HEADLIGHTS AND CLASSIFICATION LAMPS.

REPORT OF COMMITTEE ON TRAIN LIGHTING AND EQUIPMENT

COMMITTEE:

J. R. Sloan, Chairman, Chief Electrician, Pennsylvania System; C. H. Quinn, Chief Electrical Engineer, Norfolk & Western Railway; E. W. Jansen, Electrical Engineer, Illinois Central Railroad; L. S. Billau, Assistant Electrical Engineer, Baltimore & Ohio Railroad; A. J. Farrelly, Electrical Engineer, Chicago & Northwestern Railway; H. A. Currie, Assistant Electrical Engineer, New York Central Railroad; E. Wanamaker, Electrical Engineer, Chicago, Rock Island and Pacific Railway.

TO THE MEMBERS:

Your Committee were directed by the General Committee upon recommendation of the Committee on Committees to make an "Investigation to Determine the Merits of Direct Driving Axle Generators for Passenger Cars."

Your Committee interprets these instructions as being

intended to cover any mechanical form of drive other than by belt.

So far as your Committee is aware, the solution of the problem has been attempted by the following, approximately in the order given, although our information on this point is not definite.

1. W. L. Bliss.
2. E. I. Deutsch.
3. E. M. Fitz.
4. The Gould Coupler Co.—Chain Drive.
5. The Safety Car Heating & Lighting Co.
6. The Gould Coupler Co.—Shaft Drive.
7. W. A. Pitt.
8. A. H. Matthews.
9. United States Light and Heat Corporation.

The "Bliss" Drive

The drive as finally evolved, and commonly known as the "hollow shaft drive," consists essentially of the following:

1. A split two armed dog securely clamped to the axle.

2. A split hollow shaft surrounding the axle, journaled in roller bearings, whose outer race was machined in an extension of the generator frame, and carrying two diametrically opposite arms at one end.

3. Four open-wound helical springs, these springs being fitted with a casting at one end, this casting ending in a ball, and these balls fitting in spherical sockets located in the arms of the dog and in the arms of the hollow shaft.

4. A gear mounted on the hollow shaft meshing with—

5. A pinion mounted on the armature shaft.

The springs when applied were neither extended nor compressed, so that, for one direction of rotation, one pair were in compression and the other pair in tension. Reversing the direction of rotation placed the first pair in tension and the second pair in compression.

This drive and the system of axle generator regulation with which it was used were described by Mr. Bliss in a paper read before the American Institute of Electrical Engineers, February 27, 1903.

The "hollow shaft drive" was first applied during 1898 to Pullman Car Pennsylvania, operating between Jersey City and Washington over the Pennsylvania Railroad.

Previous to the use of the helical springs, which were applied in about 1902, various means of transmitting the motion from the axle to the hollow shaft had been tried out and discarded for various reasons as being unsatisfactory

Considered solely as a means of transmitting power from the car axle, the drive as shown was successful and the equipment as a whole operated satisfactorily for some time.

The equipment was removed in 1904 on account of the wear that had occurred in the outer race.

As one-half of this race was machined in the same castings as one-half of the field frame renewing the one meant renewing the other, and the expense involved was greater than was thought justifiable.

It should be noted that with this type of drive that no matter what the movement of the axle may be, only pure rotation is transmitted to the hollow shaft, and that a special axle is not required.

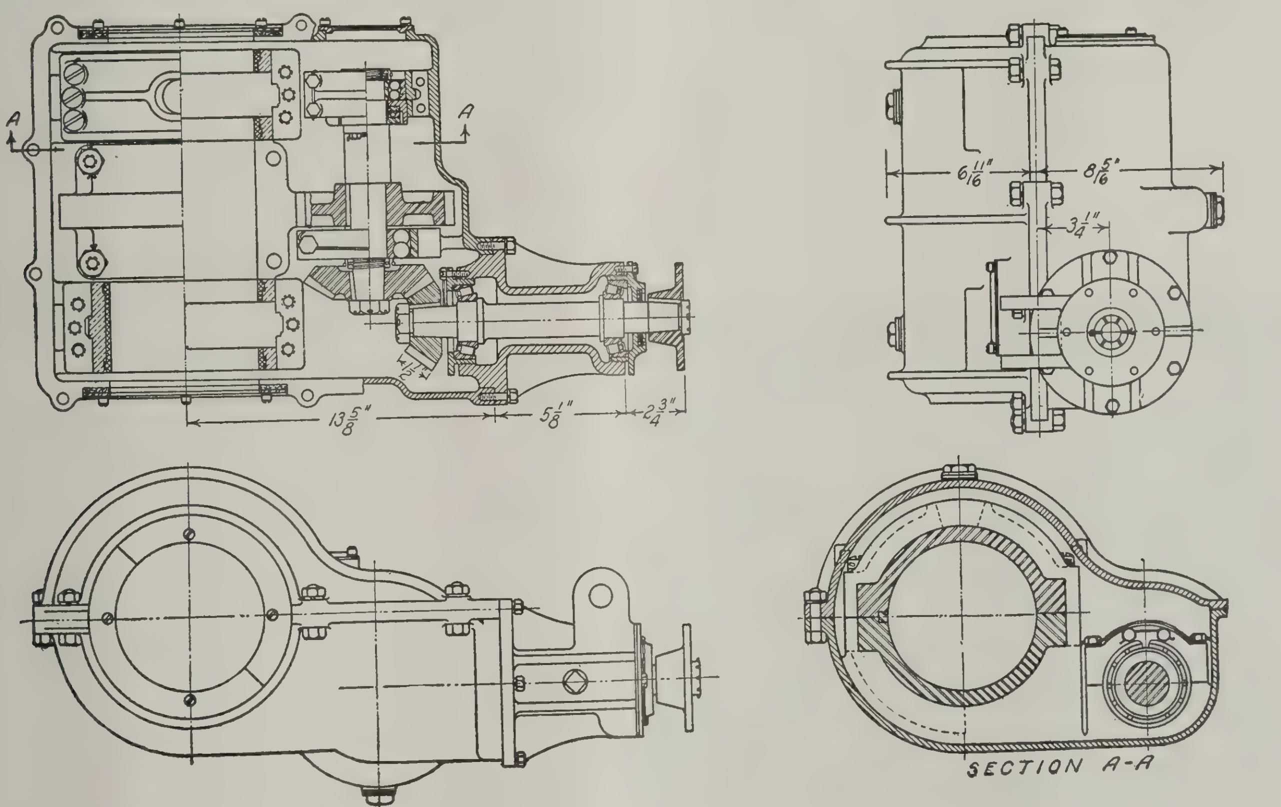


Fig. 1—Assembly Drawing of Main Part of Gould Drive

The "Deutsch" Drive

The "Deutsch" Drive consists of a split bevel gear, mounted on the axle, meshing with a bevel pinion

mounted on a shaft and carried in a split gear box surrounding both gear and pinion. The gear box was prevented from turning by a veritcal member that was attached in some manner to the truck frame as shown in the cut. The axle was turned for a bearing for the gear box, one bearing seat only being provided.

The gear was clamped to the axle by means of four bolts, all bearings in the gear box were plain sleeve bearings.

The shaft carrying the pinion had, on its outboard end, one portion of a universal joint. The other portion was carried on an extension shaft provided with a feather key, while on the other end of this shaft was a portion of a second universal joint which connected to the balance of same mounted on the end of the armature shaft.

This drive was in service on Canadian Pacific Sleeper "Narbome" and on about ten cars of the Grand Trunk and Intercolonial Railways and one car on the Lake Shore & Michigan Southern.

The drive did not give satisfaction, the trouble being ascribed by Mr. Deutsch to the fundamental mistake of providing only one bearing for the gear case and pinion support instead of two, and to the poor lubrication obtained, especially during cold weather. The result was that the gear and pinion tended to become unmeshed, ending finally in the destruction of the pinion.

These drives were in service in 1906 or 1907 and the best results were obtained on the L. S. & M. S. where 7,000 miles were obtained before the transmission required new bearing bushings and pinions.

The "Fitz" Drive

In the "Fitz" Drive the armature is built on a hollow spider having a bore sufficient to easily slip over the larg-

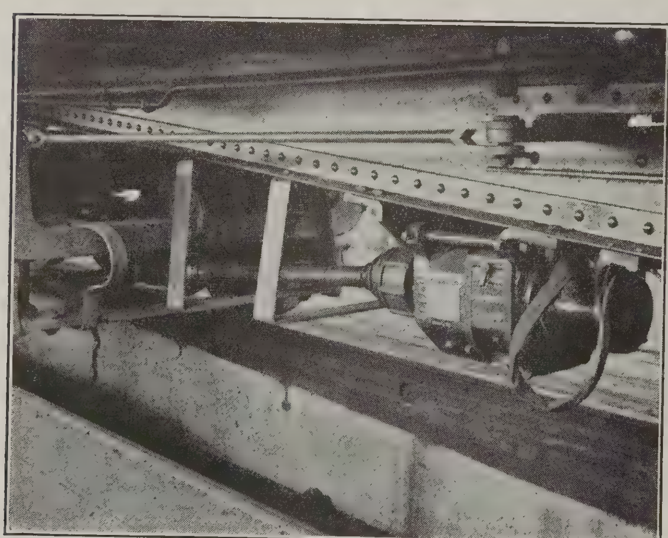


Fig. 2—Gould Direct Drive Equipment Mounted on D. L. & W. Car

est diameter of axle, this bore being enlarged in places for a short distance at each end, thus providing radial pockets in which helical springs under compression are placed, one end of the spring bearing on the circumference of the enlarged bore, the other through a steel shoe on the circumference of the axle.

Ears are also provided on the armature spider, which project through the opening between the two halves of a driving dog clamped on the axle. Motion is, therefore, transmitted from the axle to the armature through the joint action of the driving dog and the helical springs.

The driving dog also serves to retain the helical springs in the pockets.

It should be noted that with this construction, the armature being practically rigidly connected to the axle, the armature and field frame must move with the axle, partaking of all its motions.

The record of the one equipment constructed having this drive was as follows:

On test rack, friction bearing with various oils and greases	126,000 M.
On test rack, ball bearings	120,000 M.

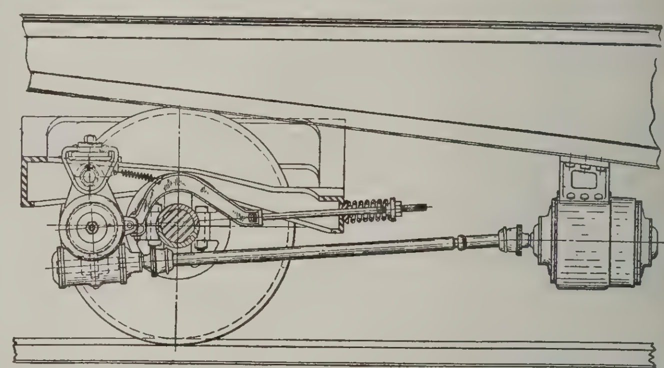


Fig. 3—Side Elevation of U. S. L. Drive

On PH coach 8243—Columbus-Cincinnati	20,000 M.
On mail car 8608—Columbus-Chicago	11,350 M.
On mail car 7262—New York-St. Louis	10,990 M.
On Pullman car "Quantico"—Columbus-St. Louis	12,670 M.
On PH coach 8236—Columbus-Cincinnati	7,200 M.
Total	308,210 M.

All the information we were able to obtain tended to show that the drive operated satisfactorily to transmit the power.

The "Gould Chain" Drive

The "Gould Coupler Company's Chain" Drive consisted of a split hub which was centered on the car axle by means of set screws, the space between the axle and interior of the hub being filled with babbitt, and clamped by bolts to the axle. A split sprocket shrouded on the outside was then mounted on and keyed to this hub.

The armature sprocket was somewhat similar in construction except that it was not split. Connection was made between the two sprockets by a Morse Silent Chain. This drive was in service on several roads and uniformly gave excellent service.

It was found, however, that it was impossible to operate it satisfactorily, using a new chain with old sprockets, or vice versa, so that when one part wore out it was necessary to renew all parts.

The armature sprocket would require renewals after about 100,000 miles service, and the expense of operation did not make it an economical proposition as compared with a belt, and therefore the drive was abandoned.

The "Safety" Drive

The first drive of the Safety Car Heating & Lighting Company consisted of a bevel gear secured to the car axle, meshing with a bevel pinion, both being enclosed

in a housing mounted on the axle and prevented from turning by a connection to the truck frame.

The pinion was mounted on a telescoping shaft provided with two universal joints, one at each end and fastened to the pinion and generator shafts by bolted flanged couplings.

The generator was mounted under the car body, the armature being parallel with the longitudinal axis of the car.

This drive was applied to Long Island R. R. car No.

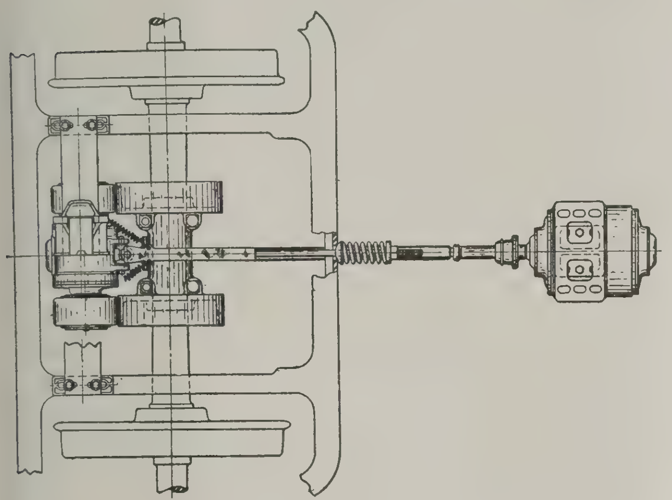


Fig. 4—Plan of U. S. L. Drive

336, February 6, 1912, and the following is its record of service:

April 12th. Pinion bearings in gear housing worn, but gears in good shape; mileage 12,700.

April 20th. First bronze pinion bearings in gear housing removed; mileage 14,337 miles.

July 23. Second pinion bearing removed; mileage 15,518 miles; total mileage 29,855 miles.

August 13th. Pinion bearing in housing found loose; total mileage 32,346 miles.

From this time on the main trouble was with the pinion bearing in the gear housing and plans were under way to try ball or roller bearings.

About October 1, 1912, the car was derailed and the shaft damaged. The general decision was not to go further with the test because the pinion bearings showed so much wear that ball or roller bearings would not prove satisfactory.

The drive was returned to the manufacturer on March 31, 1913.

The "Safety Car Heating and Lighting Company's" Drive

The "Safety Co.'s" second drive consists of two axle bushings, they being mounted on the axle a little inside the wheel fits. Each bushing carries a collar to which eye bolts are secured.

These eye bolts are connected by means of a helical spring, normally under tension, to a lug on a hollow shaft, the springs being approximately parallel with the longitudinal axis of the axle.

This hollow shaft has a sufficient internal diameter to permit the axle to move freely without fouling the shaft.

This shaft is split and is supported at each end by the outer race ways of four ball bearings, the inner raceways of which are mounted on short shafts carried by the gear housing.

The gear housing is split and is carried by seats turned on each end of the hollow shaft, and is prevented from turning by lugs attached to cross bars fastened to the axle generator suspension irons.

Mounted on the hollow shaft is a split gear meshing with a pinion which is mounted on a short shaft carried on ball bearings, parallel to the axle.

Mounted upon this same short shaft is a bevel gear meshing with a pinion mounted on a second shaft, also carried on ball bearings, perpendicular to the axle.

This second shaft is connected to the armature shaft by means of a split coupling, no universal joints being provided, as the generator is carried on suspension irons attached to the truck frame.

It should be noted that this drive does not require a special axle, and also that no provision has been made

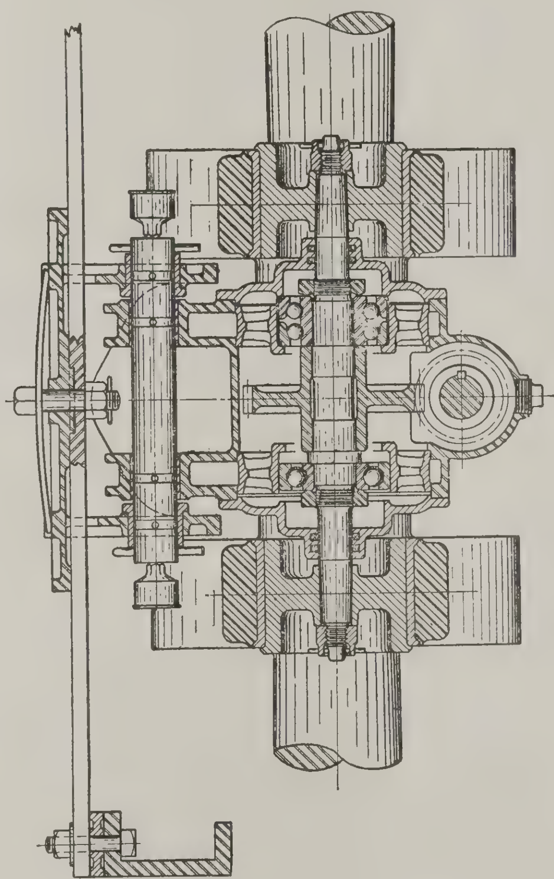


Fig. 5—Section Showing Details of Construction of U. S. L. Drive

for maintaining the pitch circles of the bevel gear and pinion in contact.

So far as is known this drive has never been used in actual service.

The "Gould" Drive

The "Gould" Shaft Drive, shown in cuts, Figs. 1 and 2, requires the use of a specal axle, as shown in the cut, Fig. 1.

A circular key, ½ inch wide and ¼ inch high, is machined on the axle midway between two bearing fits, 4½ inches long. A second key, ½ inch by ½ inch and 5¼

inches long, is fitted in a keyway cut in the axle parallel with the axis of same.

The first key acts to center the split gear on the axle and the second serves to drive the gear. The bearing fits on the axle serve as a seat for the gear box.

The 52-tooth spur gear mounted on the axle meshes with a 36-tooth spur pinion mounted on a shaft, parallel to the axle in the gear box, this shaft being carried on ball bearings.

On this shaft is a 28-tooth bevel gear, meshing with a 20-tooth bevel pinion on a second shaft perpendicular to the axle. This second shaft is carried on ball bearings mounted in the gear box and at the outboard end carries one part of a universal coupling.

The gear box is split on the horizontal diameter of the axle and is prevented from turning by a member which connects the end of the gear box to the end frame of the truck.

A telescoping shaft carrying on one end the balance of the first universal joint and on the other end a portion of a second universal joint serves to transmit the power to the armature shaft.

Mounted on the armature shaft is a safety device consisting of a coupling carrying a shear pin so that if the generator becomes damaged in any way that will throw an excessive load on the drive, this pin will shear, permitting the drive to run free. This safety device also forms the balance of the second universal coupling.

Disconnecting this safety device permits the generator to be operated as a motor for testing purposes.

The generator is mounted rigidly on the under frame of the car body with the armature shaft parallel with the longitudinal axis of the car.

Provision is made whereby the position of the bevel pinion can be adjusted so as to maintain the pitch lines of the bevel gears and pinion in contact.

The record of this drive as applied to a car on the D., L. & W. Railroad is as follows:

January 17, 1918. Car No. 582 came out of shop and went in service on local runs.

January 19, 1918. Car journal ran hot, causing car to be cut out for repairs. The opportunity was taken for inspection of internal mechanism and it was found that locking device for jack shaft adjustment had failed, and the locking pin had fallen out and into the grease. From here it traveled with the grease and got into the gears, cutting them badly before it was finally cut to pieces, but damage to gears did not necessitate removal or repair, and after cleaning out all grease and installing an improved locking device, the car went back in service on February 13, 1918, no further trouble with the locking device being experienced.

April 24, 1918. Universal on the generator was greased.

September 16, 1918. Both universals greased, and five pounds of grease put in gear box.

July 19, 1919. For purposes of investigation and inspection, the device was opened up, grease cleaned out and all parts checked up for wear. No wear was noticeable on gears, axle bearings, universals, shock absorber or hangers. No dirt or residue of any kind noted in gear case. Back lash on gears normal and all parts functioning properly. All screws and bolts tight and no apparent strain in any part. Refilled with fresh grease and put back in service.

February 20, 1920. Greased universals and put five pounds of grease in gear box.

July 14, 1920. Car came out of shop and the device was opened up for general inspection. After cleaning out the grease, conditions were found as follows:

Gears

Back lash normal, wear insignificant, just enough to show point at which teeth were coming into mesh to be properly adjusted. No adjustment necessary on jack shaft.

Main Bearings

Wear slight, not enough to permit passing of 1-64 inch shim 3/8 inch wide. Thrust surface clearance about 1/8 inch, slightly more than on previous inspection.

Dust Guards

In good shape, allowing no dirt to enter.

Universals

No wear apparent.

Telescope Joint

No wear apparent.

Suspension on Linkage

No wear apparent and free to swing.

Since the above inspection nothing has been done on this equipment. No expense or repairs other than lubrication and inspection has been necessary to date. At all times the drive has functioned properly, maintaining a steady voltage and amperage output according to the setting of the regulator. No noise is made by the device when operating and the performance up to date has been very satisfactory. A mileage of approximately 100,000 has been attained and the shock and strain due to hard suburban service have been withstood without faults developing. Some improvement as to reducing weight may be possible as well as reduction in size, the present outfit being claimed large enough to drive 15 H. P.

The following is a record of the performance of a similar drive on C. & N. W. diner 2868, applied April, 1920:

Equipment operated satisfactorily until the latter part of July, 1920, when the brass collar for adjusting the rear shaft bearing became loose. Repairs were made and the drive worked satisfactorily until the latter part of September, 1920, when the adjusting collar again worked loose. Repairs were made and operation was satisfactory until February 15, 1921, when car was taken in shop, at which time it was found that the adjusting nut had again worked loose.

The equipment was transferred to diner 2888, which is still in shop.

From the time of application to diner 2868 until its renewal, there was no failure of lights.

The "Pitt" Drive

The "Pitt" Drive consists of a split spur gear bolted to the car axle, over which a layer of felt packing has been laid.

This spur gear meshes with a spur pinion mounted on a shaft parallel with the car axle and carried on ball bearings. On this same shaft is mounted a bevel gear meshing with a bevel pinion mounted on a second shaft, perpendicular to the car axle, and carrying at its outboard end one portion of a universal coupling, by which connection is made to a telescopic shaft which carries

on one end the balance of the above universal coupling and at the other end one part of a second universal coupling, the remainder of the second universal coupling being secured to the armature shaft.

Both sets of gears and pinions are enclosed in a split housing. The housing is restrained in the horizontal plane by a cross-head through which the shaft passes, this cross-head being carried by a "U" frame attached to the truck frame.

The housing is, however, free to move, within limits, in a vertical plane, it being at once supported and prevented from turning by an inverted "U" frame, this frame being cushioned by two helical springs through which the supporting bolt passes, placed above and below the cross part of the "U" frame.

This supporting bolt at its upper end carries a short shaft on which are mounted two rollers, these rollers moving on two tracks which are formed in a casting which is secured to the underside of the car body.

So far as is known this drive has never been placed in service.

The "Matthews" Drive

The "Matthews" Drive consists of a split spur gear clamped to the axle by means of tapered wedges, drawn together with bolts as to act as an expanding bushing.

This gear meshes with four shrouded spur pinions mounted on short shafts parallel to the axle journaled in ball bearings carried by the gear bushings and serve to support the housing.

Three of these shafts run idle, the fourth carries a bevel gear which meshes with a bevel pinion mounted on a shaft perpendicular to the axle and journaled in ball bearings.

This second shaft is connected by means of a universal joint to an extension shaft provided with a sliding joint, and this in turn is connected to the armature shaft by a second universal joint.

The housing is at once cushioned and prevented from turning by a connection to the truck frame, the two portions of which are connected together through a helical spring, so arranged as to constrain the movement of the housing for both directions of rotation. From the cut the bevel gears are apparently run exposed to the weather and no provision is shown for maintaining the pitch circles of the bevel gears in contact.

So far as is known, this drive has never been tried out in service.

"United States Light & Heat Corporation" Drive

The "U. S. L." Drive, as shown in Figs. 3, 4 and 5, consists of a 17-inch split twin steel pulley secured to a standard axle by means of through bolts.

These pulleys drive by contact two 10-inch pulleys or friction wheels which are made of rubber tires molded on steel rims, the rims being pressed on the center hub of the pulley.

These tires are the standard tire as used on industrial automobile trucks. These pulleys are mounted on the ends of a short shaft, parallel to the axle, this shaft being supported by two sets of ball bearings which are carried from a housing pivoting about a horizontal cylindrical bar in a position approximately vertically above the pulley shaft.

This bar in turn is supported by a steel casting mounted on a member which is supported by the truck frame.

This casting is arranged so that it will pivot in the horizontal plane about a bolt, equalizing the pressure of the friction wheels on the pulleys.

At the center of the shaft carrying the friction wheels a worm wheel is mounted which meshes with a worm mounted on a second shaft perpendicular to the axle. This second shaft is also carried on ball bearings which are mounted in a casting which is bolted to the casting forming the housing for the worm wheel.

The worm shaft is connected to the shaft of the axle generator, which is mounted longitudinally under the car body by means of two universal couplings and an extension shaft with a sliding joint.

Pressure between the pulleys and the friction wheels is assured by a bar attached to the housing midway between the pulley, curved so as to pass over the axle and extending beyond the end sill of the truck and having a thread cut on the end.

Beyond the truck frame this rod passes through a helical spring and the pressure between the pulley and friction wheel is adjusted by the amount that this spring is compressed.

This drive has been operating for some time in experimental service in the shop, but has never been used in service on the road.

It will be conceded by all who are familiar with present-day operation of axle generators that, at the present time, failure of the drive is the cause of a larger number of failures of light than any other one item.

The records of the company operating the largest number of axle generators shows that 18.4 per cent of the lighting failures and 25.2 per cent of the equipment failures are due to the drive.

The causes of the trouble experienced with belt drive are many and various, but they are not germane to the subject assigned.

Their effect on car lighting, however, is and has been so detrimental that, as has been shown, repeated efforts have been made to design a satisfactory positive drive which would eliminate the belt.

The advantages of such a form of drive are:

1. Decreased liability of failure of drive, resulting in
2. Decreased liability of failure of light.
3. Decreased liability of deterioration of battery, due to undercharging of battery on account of the belt slipping and sulphating on account of battery becoming discharged and standing in that condition.
4. Decreased liability of having train detentions.
5. Decreased liability of annoyance to passengers, due to flickering of lights caused by belt slipping and to failure of lights due to loss of belt.
6. Positive drive under all conditions of weather.
7. Elimination of belt tension device, simplification of suspension, with consequent reduction in first cost and cost of maintenance of these parts of the equipment.

The disadvantages of such a form of drive are:

1. Increase in first cost of drive.
2. Increase in cost of application.
3. Increase in length of time of train detention when drive does fail.

4. Increased difficulty in testing generator by motoring.

To be really successful, the direct drive should, of course, in addition to its advantages over the belt drive, be capable of being operated at a total cost comparable with the total cost of operating the belt drive.

In order to determine what the cost of operating a belt drive might be, your Committee presents the accompanying data as furnished by various railroads, from which it will be noted that the mileage per belt varies from 5,132 to 84,775, and that the average percentage renewals per belt per month vary from 5.8 to 85.6.

Interest

Axle pulley bushing at	$ 4.95
Axle pulley at	18.00
Armature pulley at	12.00
Belt at	2.84
Fasteners at	.06
Dfference in cost of suspension	75.00
Interest at $0.06 on $112.85	6.77
Total	$56.04

Therefore, as an economical proposition, considering the drive only, the direct drive, on the basis of the figures used in making this comparison, should be capable of being operated at a total cost, counting in operation, maintenance, depreciation and interest at not more than $56.00 per year.

DATA ON BELTS—BODY HUNG GENERATORS

	1 K. W.			2 K. W.			3 K. W.										
Railroad	N Y C	N & W	A C L	N Y C	N Y C	N Y C	N Y C	B & O	B & O	B & O	D L & W	I C	I C	I C	A C L	A C L	A C L
Make of Generator	Safety	U. S.L.	Safety	Safety	U.S.L.	Gould	Gould	Safety	Stone Frank-lin	U.S.L.	Gould	Safety	Gould	Gould	Safety	U.S.L.	Stone Frank-lin
No. of generators in service	26	70	6	2	77	33	84	60	92	50	129	126	84	237	11	10	7
Type of suspension	N Y C	N & W	.....	N Y C	N Y C	N Y C	N Y C	und. frame	Stone	U.S.L.	.....	und. frame	Gould	1 C	.....	.....	.....
Width of belt, in.	4	4	4	4	5	4	5	4	4	4	4	4	4	4	4	4	4
Plies of belt	4	4	5	4	4	4	4	5	4	5	5	4	4	4	5	5	4
Av. length of belt, ft.-in.	15	15	13	15	14-7	14-7	14-7	14-5	15	14-9	.....	13-6	13-6	14	14-6	13	13
Type of fastener	C	W	C	C	C	C	C	W	W	C	C, W	W	W	C, W	C	C	W
Diam. of axle pulley, in.	19	17	17	19	19	19	19	17	17	17	18	17	17	20	17	17	17
Diam. of armature pulley, in.	8	6.5	5.5	8	10	8	8	5.5	5.5	8	.....	5.5	8	11	5.5	8	5.5
Belt renewals in % of cars equipped:																	
October, 1919	8	.....	.....	.....	26	39	30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
November, 1919	38	.....	.....	.....	47	42	8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
December, 1919	46	.....	.....	.....	100	85	64	120	69	58	.....	35.5	31.6	13	.....	.....	.....
January, 1920	70	5.4	50	50	205	218	140	113	69	42	40.5	120	74	57	64	80	29
February, 1920	35	8.6	66	50	102	106	75	77	67	70	30.5	65	61	24	64	240	43
March, 1920	27	7.3	50	.....	58	63	69	62	64	42	31	67	44	19	73	150	85
April, 1920	15	8.6	16	.....	48	60	41.5	93	70	30	14	43	51	24	110	20	100
May, 1920	35	7.3	66	.....	31	30	31	113	54	48	8.5	47	45	12	45	30	29
June, 1920	15	5.4	84	.....	38	30	21.5	125	61	38	21.6	55	45	19	64	50	29
July, 1920	23	4.3	33	.....	36	36	22.5	88	48	36	31	54	57	22	91	70	29
August, 1920	42	5.4	0	50	40	27	28.5	62	73	58	19.4	50	61	23	100	20	14
September, 1920	11	2.7	33	50	41	60	21.5	75	44	28	4.7	51	55	19	54	20	29
October, 1920	.....	1.3	0	.....	.....	.....	.....	50	55	10	3.9	57	52	23	54	70	29
November, 1920	.....	5.4	66	.....	.....	.....	.....	50	76	26	16.2	64	44	20	110	50	43
December, 1920	.....	7.3	33	.....	.....	.....	.....	.....	.....	.....	17	.....	.....	.....	128	50	43
Total belts applied	95	49	30	4	593	264	463	617	694	244	307	894	520	655	105	85	35
Av. % renewals per month	30.4	5.8	41.7	16.7	64.2	66.6	45.9	85.6	62.7	40.7	19.8	59.1	51.5	23	79.5	70.8	41.6
Av. miles per belt	13,759	84,775	.....	5,132	8,929	7,822	7,257	.....	.....	.....	.....	17,000	20,000	44,000	.....	.....	.....

As these figures vary so widely on the several railroads, each railroad should, when making such a comparison, make use of its own data.

However, as a guide to arrive at a figure which might represent the cost of operating, we submit the following:

Assumptions

Miles service per belt	10,000	
Miles service per month per car	5,000	
Length, width and ply of belt	14 ft. 0 in. by 4 in. by 5-ply.	
Cost per foot of belt	$0.4725	
Type of belt fastener	Crescent	
Cost of fasteners per belt	$0.155	
Axle pulley bushing life, cost	20 yrs.	$ 4.95
Axle pulley life, cost	10 yrs.	18.00
Armature pulley life, cost	3 yrs.	12.00
Armature pulley times turned, cost per turning	3	.90
Labor to cut and apply belt, time, cost	20 min.	.28
Difference in cost of suspension, including belt tension device		75.00

Cost per year based on above Assumptions.

Operation

6-14 ft. 0 in. by 4 in. by 5-ply belt, at $0.4725 per foot	$39.69	
6 sets of fasteners, at $0.155 per set	.93	
6 by 20 minutes for application belt, at $0.85 per hour	1.70	
Cost of one turning of armature pulley	.90	
		$43.22

Depreciation

Axle pulley bushing, $0.05 by $4.95	$0.25	
Axle pulley, $0.10 by $18.00	1.80	
Armature pulley, $0.33 by $12.00	4.00	
		$6.05

There are, however, other items of expense due to the use of the belt drive which must be considered in making a true comparison.

These items are:

1. Cost of charging current at terminals necessitated by car arriving with batteries discharged due to belt slipping or being lost.

2. Depreciation of battery due to sulphation on account of battery being discharged and remaining for a greater or less time in that condition, due to belt slipping or being lost.

3. Depreciation of battery due to "reserve" material being formed into "active" material before needed, due to sloughing off of sulphated active material and "forming" charge resulting from low current to battery caused by slipping of belt.

4. Loss of patronage due to annoyance to passengers caused by the "flickering" or failure of the lights due to defects of the belt drive.

Objections 1, 2 and 3 may, but do not necessarily, apply to generators designed to operate with slipping belt.

The points that, in the judgment of your Committee, should be avoided in designing a positive drive for axle generators are:

1. Construction which necessitates the use of a "special" axle.

2. Construction which in any way changes a "standard" axle.
3. Construction which necessitates the removal of the wheel from the axle in order that the equipment may be applied.
4. Construction which uses a helical spring in a plane other than that perpendicular to its axis.
5. Construction which, on account of wear, necessitates scrapping of material other than the material worn.
6. Construction which does not provide for maintaining pitch circles of bevel gears in contact
7. Construction which does not readily permit the turning of wheels in center drive wheel lathes.
8. Construction which does not provide for the full movement of the axle in all planes.
9. Construction that does not provide efficient lubrication and protection to all working surfaces from dirt and grit.

The points that, in the judgment of your Committee, should be provided in the design of a positive drive for axle generators are:

1. Connection to axle that can readily be removed.
2. Mounting of the axle generator on the truck or underframe of car in the simplest possible manner.
3. That the universal joints, if used, should have a free angular movement in any direction in excess of the angle between center lines of truck and car body as found on the curve of least radius over which the car is capable of moving in service condition.
4. That a safety device should preferably be provided which will operate to break the connection between the drive and generator, in the event of the drive tending to become overloaded.
5. That the generators should be so mounted as to provide a maximum of accessibility.
6. That means should be provided by which the generator may be readily "motored."

Your Committee feels that at the present time there is no type of direct or positive drive which does not include features that are objectionable to the extent of practically prohibiting its general use, nor does any drive possess all of the points that we consider necessary.

Your Committee is, however, of the opinion that the advantages of the direct drive are of such importance as to justify its further development and further that its use would be justifiable even at a cost in excess of the belt drive.

Your Committee believes that there is a demand for a direct or positive drive and that its development should be encouraged by all concerned.

Specifications for Axle Generators—1920 Report

Recommended Practice

There has been more or less criticism of regulation limits as given for the lamp regulator in these specifications under the heading "6. Lamp Regulator (i), 1 and 2."

As 1 now reads the greater the load on the regulator the greater the permissible drop in voltage.

Due to the characteristics of the battery, the terminal voltage of the battery also decreases as the load increases.

Therefore, we have incurred a double drop in lamp voltage, while what is actually desired is a constant lamp voltage.

As this condition is impossible of attainment under the conditions given, i. e., a battery voltage of 31 volts or less, the obvious thing to do is to set a limit for the maximum conditions which will give the greatest drop permissible and for any conditions less than the maximum, the drop in voltage will then be less.

Your Committee have therefore agreed that paragraph 6 i. 1 should read as follows, the words in parentheses being those of the present text that we eliminate:

> "6 i. 1. With the battery discharging and with the battery voltage 31 volts or less, the drop in voltage across the terminals of the lamp regulator resistance shall not exceed 1 volt (per 25 amperes flowing) for the connected lamp load."

Paragraph 6, i 2 gives certain voltage limits for a current value to be specified by the railroad company and the note recommends that this current value be 125 per cent of the connected lamp load. There is no necessity for specifying a load greater than will be encountered in service.

Your Committee has therefore agreed that paragraph

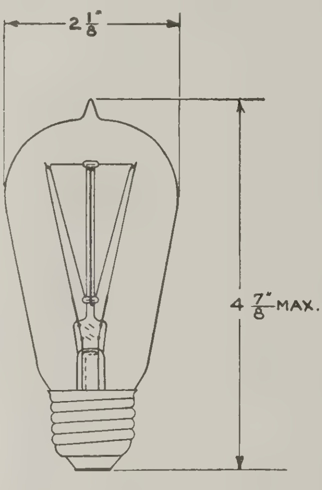


Fig. 6—15-Watt, 30-34-Volt, S-17 Mazda B Lamp

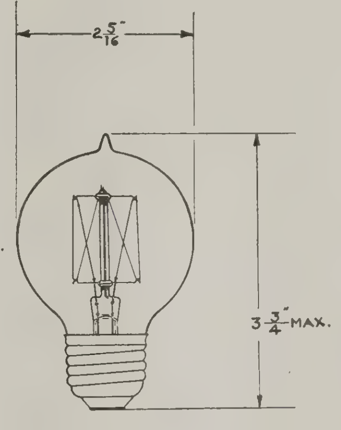


Fig. 7—15 and 25-Watt, 30-34-Volt, G-18½ Mazda B Lamp

6 i 2 should read as follows, the words in parentheses being those of the present text that we eliminate:

> "6 i. 2. With armature r. p. m. increasing at an approximately uniform rate from minimum full load speed to maximum speed in not more than five minutes and again decreasing to its original value, the voltage shall be maintained at . . . volts plus or minus one volt (at any current value not exceeding . . . . amperes) at any current value equal to or less than the connected lamp load."

Train Lighting Lamps

The present recommended practice shows only the limiting dimensions of two sizes each of two types of bulbs, i. e., the "G" bulb in the 18½ and 30 size and the "S" bulb in the 17 and 19 size.

This information does not fully describe the lamps, and furthermore the type "C" lamp has now been developed and with it a new style of bulb has been introduced.

Your Committee therefore deems it advisable to present a full schedule of train lighting lamps divided into two

portions, a standard or regular schedule and a special or intermediate schedule.

From the point of view of cost of manufacture, as well as stocks to be carried by the railroads and the lamp manufacturers, it is desirable to reduce the number of kinds of lamps used for train lighting purposes to a minimum consistent with meeting the requirements for illumination of the various classes of passenger train cars. Table I covers the standard or regular schedule of tungsten train lighting lamps as listed by the lamp manufacturers. Table II covers the special or intermediate schedule of tungsten train lighting lamps which represent lamps that are available but that are not regularly listed by the lamp manufacturers.

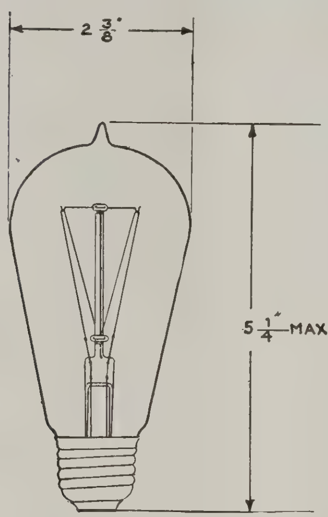


Fig. 8—50-Watt, 30-34-Volt, S-19 Mazda B Lamp

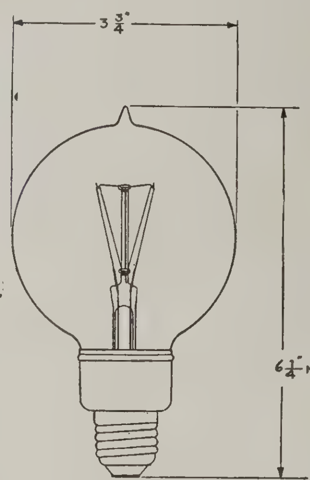


Fig. 9—50-Watt, 30-34-Volt, G-30 Mazda B Lamp

TABLE I.

Standard or Regular Schedule

Size in Watts.	Voltages.	Type and Size of Bulb.	Vacuum (B) or Gas Filled (C).
10	30-34	S-17, G-18½	B
15	30-34	S-17, G-18½	B
25	30-34	S-17, G-18½	B
50	30-34	S-19, G-30	B
50	30-34	PS-20	C
75	30-34	PS-22	C
100	30-34	PS-25	C

TABLE II.

Special or Intermediate Schedule

Size in Watts.	Voltages.	Type and Size of Bulb.	Vacuum (B) or Gas Filled (C).
15	30-34	PS-16	C (Diffusing Bulb)
20	30-34	S-17, G-18½	B
25	30-34	PS-16	C (Diffusing Bulb)
50	30-34	PS-20	C (White Bulb)
15	60-65	S-17, G-18½	B
25	60-65	S-17, G-18½	B
50	60-65	S-19, G-30	B
75	60-65	PS-22	C
100	60-65	PS-25	C

Your Committee believes that the following sizes will meet the general requirements of train lighting service and that the railroads should confine their demands to these as far as possible.

Size in Watts.	Voltages.	Type and Size of Bulb.	Vacuum (B) or Gas Filled (C).
15	30-34	S-17	B
25	30-34	S-17	B
50	30-34	PS-20	C
75	30-34	PS-22	C

The straight side or "S" type bulb is recommended in place of the round or "G" bulb on account of its much lower cost. The 50-watt, PS-20 tungsten gas filled or "C" lamp is a comparatively new development, but is recommended in place of the vacuum lamp in that it provides 50 per cent more illumination without increase in current consumption.

The accompanying figures, 6 to 11, inclusive, show the dimension and shapes of the different styles of bulbs.

Your Committee therefore recommends:

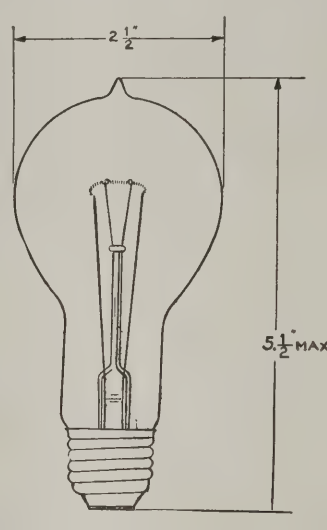


Fig. 10—50-Watt, 30-34-Volt, PS-20 Mazda C Lamp

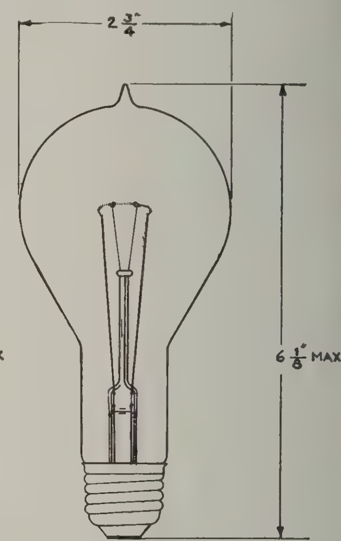


Fig. 11—75-Watt, 30-34-Volt, PS-22 Mazda C Lamp

1. That that portion of their report pertaining to the direct or positive drive on which a report was ordered be accepted.

2. That the proposed change in paragraphs 6 i. 1 and 2 of the specification for axle generators be referred to letter ballot as Recommended Practice.

3. That the schedule of Train Lighting Lamps, together with the limiting dimensions as given, be referred to letter ballot as Recommended Practice.

Respectfully submitted,

Committee on Train Lighting and Equipment.

Discussion of Report on Locomotive Headlight and Classification Lamps by the American Railway Association

In the absence of the chairman, this report was read before the convention of American Railway Association by A. R. Ayers, New York, Chicago & St. Louis, who said:

"In connection with ball bearings I might call attention to the fact that bearings Nos. 306, 308 and 406 carry with them certain definite dimensions of the fit of the shaft in the bearing and the size of the bore in the housing. The size of the ball varies a little in different makes of bearings, so that the committee was not able to select the size of the ball that had to be covered by the shaft fit and the housing bore. By reference to the last column 'size of ball,' you will see that it works out fairly well."

During the reading of this report, Mr. Ayers further said: "I would call your particular attention to one dimension in that recommendation and that is the spacing

of the two bolt holes at the turbine end. Since this report was agreed upon by the committee, it has developed that the resulting spread of bolts to eleven inches, in some cases, would be so wide that some of the boiler plate brackets now on locomotives would not take the new bolt spacing. The committee will be asked to consider changing their recommendation from 5½ in. from a longitudinal center line, to 4½ in. I think, for future designs, all of the manufacturers could meet the 9 in. dimension.

The committee thinks recommendation No. 3 is the most important of all.

C. T. Ripley (Santa Fe): I feel that the committee should be in a position to make definite recommendation as to the use of the glass reflector. These have now been in service for five years ,and have proven so superior both in service and maintenance that there appears to be no reason for the application of silver reflectors—at least to new power. I do not know what is meant by official tests, but there are plenty of railroad tests which show that a glass reflector is the best now available.

As regards paragraph 5, your committee should discuss with the committee of the Railway Electrical Engineers, the question of the voltage of cab lamps. About two years ago this voltage was reduced from 34 to 33. We all know that we cannot hold the voltage of our generators constant. The change in voltage from 34 to 33 in the rating of the lamps means added life. Under the present conditions, we cannot buy 34-volt lamps. The 250-watt headlight lamp also needs attention, as a great many replacements are due to the bulbs becoming loose from the base. This can be overcome by lengthening the base, and I would like to see this new type lamp made standard.

H. B. Bohan (N. P.): I would like to concur with the gentleman's remarks on the glass reflectors. The experience of the Santa Fe has been the same as the Northern Pacific. I should also like to ask if any of the members have had any experience on the so-called illuminated dials and gages on cab lamps. We have been making quite a few experiments with illuminated gages for use in the caboose cupola and I just received a report at Atlantic City that the success of that type of gage has been uniformly good. The more we can keep off of the boiler, the better it is. If we could use an illuminated gage for the various gages in locomotive cabs, we would eliminate just so much wiring and conduits.

C. F. Giles (L. & N.): I would like to call attention to the development of the air-tight headlight casting that is being worked out by one of the manufacturers. I think it is worthy of the consideration of the committee in connection with their next year's report. We have made a test of one of them in a roundhouse for six or seven months, and it appears to be very satisfactory. The idea has been developed from the experience that people have had with the air-tight headlight on automobiles. The headlight reflector does not corrode nearly as readily when air is admitted to the casing.

H. H. Bentley (C. & N. W.): I am heartily in sympathy with what Mr. Ripley said about the glass headlight reflector, but it seems to me that we ought certainly to come to some conclusion as to what size reflector we want to use. It would not only help the manufacturers, but would help everybody else, and it seems to me that we ought to conduct a test to see which is the better size reflector for all purposes; that is, either 12, 14 or 16 in., as the case may be. I would recommend that the committee be authorized and instructed to make such tests as will demonstrate conclusively the size of reflector that should be made standard.

There is one thing that our railroad copied from the Illinois Central in connection with headlights, and that is a shield over the headlight casing. I am just bringing it to your attention so that you may think about it. We heard from Mr. Bell that they were having very good results from a shield over the top of the headlight casing and the engineers were reported to be very much in favor of it. It kept the rays down and permitted them to see the signals much better than they could otherwise. We put a lot of them on our road and have now made it standard. I do not know whether any of you have seen it, but if you want a blueprint, I will be glad to furnish one. It certainly is working out very satisfactorily.

During the Railroad Administration there was some attempt made at standardization and, as I recall it, the committee at that time decided on a standard base for headlights. I am wondering how that standard conforms to or varies from the one that is now being recommended by the committee.

I am inclined to think that we ought to get away from the use of sheet steel for headlight casings. It seems to me that the development has been carried far enough so that some composition casing, which would be light in weight and not corrode, would be more satisfactory than the steel casing.

We had some trouble with the turbo-generator and it got so bad that finally we adopted a flexible connection which has apparently overcome all the trouble.

I am heartily in sympathy with recommendation No. 3 which reads: "Extensive repairs, and particularly repairs to rotating parts, to be done only at shops or designated points where adequate facilities are available." That is the practice we have had for a good many years. Before that we were having all sorts of improper repairs made to the air pumps with many failures on the road. Taking pumps to the place where we had the proper repair facilities reduced our air pump failures. I am satisfied in the case of a little turbo-generator which a man can carry around, that it should be taken to the repair shsop for repairs instead of making them on the locomotive.

W. L. Bean (N. Y., N. H. & H.): I think that for road use the 16-in. glass reflector will be found sufficient and in comparison with the silvered steel reflector, we found that after it has been out for a while the 14-in. glass reflector will give higher illumination than the old style reflector.

As to keeping the diameter of the reflector down to just what may be necessary; I believe that to be particularly important in working out a desirable cast case because the weight is so much greater as compared with sheet iron. The cost of the reflector also increases rapidly with the increase in diameter. I think it will be found that 14-in. reflectors will be sufficient for road use and 12-in. reflectors for yard use. By the adoption of cast cases, the maintenance will be negligible to what it is now, especially in such locations as on the tenders of switching engines.

MR. AYERS: Some of the electrical people can correct me if I am mistaken about the 33-volt and 34-volt lamp but my impression is that the voltage for a locomotive lamp should be the same as the car lighting lamp. If you put in a lamp with too high a voltage rating, the car-lighting battery will not suply it to its full illuminating power.

About spacing the headlight stand, I am not able to answer Mr. Bentley's question directly. The space recommended has little to do with any other spacing for the reason that almost no two of the stands are alike. We found different combinations. Some stands have bolts with a wide spread and others with a narrow spread; what the committee had to do was to get the generator manufacturers together to see what compromise could be made which would not interfere with the operation of the equipment.

MR. RIPLEY: It is true that that particular type of lamp (15-watt lamp) is used for car platforms and a different type of lamp is recommended for use in car lighting. Why cut down the lighting of all the headlight lamps to accommodate a few lamps on platforms?

FRANK J. HILL (M. C.): In answer to Mr. Ripley's remarks; I do not think there is any difference in the illuminating value of a 33- and a 34-volt lamp. If you order a 33-volt lamp you will probably get a 34-volt lamp. That is something you will have to take up with the lamp manufacturer. If you get a 33-volt lamp you get a lamp that has a range of one volt either way.

CHAIRMAN TOLLERTON: In this discussion we would particularly like to hear from the electricians who have charge of this equipment and especially if they are having any troubles or difficulties in maintenance of the generators or other parts of the light equipment. This committee on electric headlights is seeking information. They have asked for certain instructions from the members of the convention and they cannot work intelligently unless they get some ideas of the troubles you are having.

C. E. BROOKS (Canadian National): In connection with item No. 3, I believe that about 75 per cent of shaft renewals are due to the fact that the bearings are loose and this is generally due to the fact that the internal diameter of the bearing is too small. It seems to me that the committee could well cut down the number of choices that we have in the bearing and that we could get down to a bearing such as No. 308 which has the largest internal diameter.

MR. AYERS: In selecting a size of bearings, the committee had to be careful not to place obstruction in the way of mechanical developments. There are several combinations of bearings for supporting generator shafting: One case in which the bearing is on the extreme edge of the shaft; another where both bearings are in the center, between the turbine and armature; another where the bearing is at the generator end; and another where the bearing is at the turbine end. Where there is a bearing in the center, it has to slip over any intermediate features and then too the bearing at the outer end of the shaft would nominally have a smaller bore. I think I am correct in saying that all three of the bearings recommended are larger than those commonly in use. The committee considered particularly the inside diameter, that is, the shaft diameter; there are bearings in use today that have a considerably smaller shaft diameter than the No. 306, which is the smallest one recommended by the committee. I believe it will be found that the construction is an improvement upon the previous method.

G. P. KEMPF (P. & W. V.): Has the committee made any investigation as to lowering the generator with the shaft parallel with the center line of the boiler, or at right angles to it? I believe there have been some investigations as to decreasing the maintenance cost and insuring a longer life of the generator by making some rearrangement of this kind.

MR. CASTLE (N. Y., N. H. & H.): In looking over the committee's recommendation there does not seem to be any reference to the consideration of lock nuts and lock washers. I think that matter should be considered in this connection. One other item is the size of pipe of the turbo-generator. On most roads the turbo-generator is located near the source of supply at the head of the cab and the ½-in. pipe will be found adequate, but it is a question where you carry the pipe up to the headlight near the stock, or even on the deck below the smoke box, whether the size of the pipe should be increased.

The last item that I wish to mention is the ⅜-in. bolts in the headlight casing. If a smaller and more flexible casing is used it may be only a question of time when corrosion takes place and the bolts will be too small.

CHAIRMAN TOLLERTON: Mr. Ayers, will you state whether the committee has considered the question relative to generator location?

A. R. AYERS: There was considerable discussion about that and I think one road (Illinois Central) has made some experiments along that line. The question of the gyroscopic action was discussed; also the thrust of the bearings due to the sidewise oscillation of the locomotive but the jar on headlights, longitudinally due to a rough coupling, is probably a great deal more severe than side oscillation due to rolling. There are so many arguments on both sides of the question that the committee could not reach any conclusion. There did not seem to be any definite evidence that one method was better than another.

W. J. BOHAN, (N. P.): I would like to comment a little on what Mr. Giles had to say about the air-tight headlight casing. I do not believe that a headlight case could be continued on a locomotive indefinitely without developing leakage. We must not lose sight of the fact that the silvered reflector will corrode from gases, while the glass headlight will not.

One more word about Mr. Bentley's remark as to the size of the headlight casing: I do not think that that matter should be taken too seriously, either. What we want on a locomotive is a headlight case that will give us the most returns for the expenditure and the handling of the headlight case is not a very serious matter. The tendency is to charge very nearly twice as much for the lighter alloy casings and I believe we could get the straight, cast-iron case down to where it will be reasonable to handle and at a very much lower price.

MR. RIPLEY: The location of the turbo-generator does make a difference. It has been found in actual service that it is considerably more difficult to maintain bearings on any turbine that is located longitudinally of the boiler. Our road is one of the earliest roads to use electric headlights and we have found to our entire satisfaction that the turbo-generator should be located transversely of the boiler.

MR. AYERS: Defective bearings are probably responsible for more turbo-generator trouble than any other one thing because, as bearings wear, the armature gets down on the field. The ball gearing manufacturers told us that the bearings already in service were capable of higher speeds and far greater loads than anything they had to carry, which brings out the great importance of doing everything possible to keep the bearings in good shape.

I want to call your special attention to what is said about filtering the oil and keeping the oil channels clean. As time goes on and bearings with dirt shields and dust shields become more available, I believe that question should be considered. In other words, if we can keep the bearings on these machines in first-class condition, at all times, a great deal of our trouble will disappear.

The balancing of the rotating parts at the time of repair is very important. The chance is slight of being able to take off a carefully balanced turbine wheel and replace it with a turbine wheel out of stock and have that turbine wheel run at a good balance, three or four thousand revolutions per minute. In spite of this fact, I doubt if a great many people are rebalancing armatures or rotating parts after they make repairs. These are things we will have to give a great deal of attention to if we are going to keep these machines in good operating condition. (*It was voted that the report be accepted and submitted to letter ballot.*)

Discussion of Train Lighting and Equipment by the American Railway Association

Mr. Jansen: Your committee in writing this report has described all the various drives of which it had knowledge at the time and included, as will be seen from the report, a drawing showing each drive. The drawings submitted were unfortunately of such a character that they did not lend themselves to reproduction by photographic process, and it was, therefore, considered advisable to omit all except those drives which were in commercial use. We have since learned of two other drives, one by D. C. Wilson and one by G. G. Milne, but neither of these has been developed, so far as we know, beyond the patent stage. We have also given a list of what we consider to be the essential features that such a drive must possess, and also a list of the features we consider should be avoided.

With regard to the Gould shaft drives in service, as mentioned in the report, we are advised that the one on the C. & N. W., "has not been opened or touched since March 15, 1921, and has been performing in an entirely satisfactory manner."

The record of the one on the D. L. & W. since July 14, 1920, is,

Jan. 25, 1921: Regreased gear box and universal shaft drive joints.

July 25, 1921: Regreased gear box and universal shaft drive joints.

Feb. 23, 1922: Regreased gear box and universal shaft drive joints.

Two hours labor and eight pounds of grease were used each time.

The equipment has been inspected subsequent to May 24, and considerable wear was found between the main axle and the intermediate gear teeth. The bevel gear showed practically no wear and was in good condition. The wear on the main gear was evidently due to its not being hardened as was the bevel gear.

In the 1918 report your committee recommended that the axle pulley bushing, if one is used, be 7.5 inches in diameter, and not less than 8.5 inches long. Apparently these dimensions were not sufficient, as we learned there is a considerable number of various types and sizes of the bushings called for, the variation between them being slight. This condition tends to increase the cost and prevent the manufacturer from manufacturing for stock.

Considerable interest is now being manifested in the so-called wide face pulley, the advocates of the same claiming that its use conduces, especially with body-hung generators, to increase the mileage obtained from the belt.

It has been suggested that the committee investigate these two subjects as part of their next year's work and the committee would so recommend.

I want to call your attention especially to the fact that all roads, where they can, should make use of straight-side lamps; they cost considerably less than round lamps. At present the tendency is to get the generators off the truck and on the car body. Members of this committee developed first a heavy cast pulley that occupied the entire axle length. They have changed that and are getting out a pressed steel pulley 18 inches in diameter and are mounting the generators so that the generator pulley is on the centre line of the car. I think all railroads should come to that, because it will result in reducing belt loss practically one half. A test was made on a 23-deg. curve, 224-ft. radius, and on the sharpest point of the curve the belt had still two inches to go before it struck the pulley flange. The belt at all points rested on the axle pulley, and if it had been a straight-face axle pulley the outer edge would be against the flange and it would have tended to go over.

A truss rod was offset so as to get the pulley on the center line of the car. A sort of S-form that was at least 1½ inches in diameter and about 6 inches wide was used to take up the strain, and as it was believed that it would not in any way interfere with the brakes, the brake beam was also offset.

The present cost of car lighting can be cut down by taking care of body-hung generators and getting a proper axle pulley. We are now using 17-inch and 20-inch pulleys, but I believe all roads could go to 18½-inch pulleys, and if they get their clearance for the brake rigging and can get the pulley on the center line of the car, it will greatly reduce the cost.

Hydro-electric Scheme in Ceylon.—We understand that there is every possibility of a hydro-electric scheme, worked on the lines laid down four years ago by an engineer of the Public Works Department, being proceeded with in Ceylon in the near future. The Government is taking steps to acquire the Hardenhuish Valley, near Watawala, which is 20 acres in extent and will form the intake reservoir whence there will be formed the biggest head of electric power in the East. The Government has favored the scheme for the generation of electricity from what is known as the Aberdeen-Laxapanagalla scheme, that is, to combine the flow of two streams into the Hardenhuish Valley, and then lead the water down a slope which would give a pressure of 2,000 feet. This would enable the generation of 200,000 horse-power of electricity.

Entrance to Young's Million Dollar Pier

R. S. M. A. Exhibition Features Many New Devices

Electrical Equipment Forms an Important Adjunct in Much of the New Apparatus Displayed

THE Railway Supply Manufacturers' Association and its exhibit committee made a record this year at the Atlantic City conventions. Shipments arrived earlier than usual and were promptly taken to the pier and installed with clock-like precision. Everything worked smoothly and on time and all was in readiness when the exhibition opened on the morning of June 14.

The scope of the exhibits was without question the largest in the history of the R. S. M. A. It ranged from the many new features in small equipment devices for cars and locomotives to the complete cars and locomotives themselves. The track exhibit on Mississippi Avenue near the Boardwalk showed a number of locomotives and passenger and freight cars. Many made a careful inspection and study of this exhibit.

At one time during the past winter it looked as if the entire space in Machinery Hall would not be used by the manufacturers of machinery and tools. Subsequently, however, every square foot of space was taken and on the opening day there was presented for the inspection of the railway men the most complete machine tool exhibit ever made. In order to take care of such an exhibit it was found necessary for operating purposes to increase the air and electric power more than 50 per cent over previous years.

Ninety-six thousand square feet of exhibit space—all the available space on the pier, except the balcony, which has been found not desirable—was used this year by 341 exhibitors. Some time ago it was found that there was not enough space to go around and make every applicant happy. In many instances, therefore, the exhibit committee was simply compelled to allot much less space to applicants than had been asked. Many of the large companies in the full convention spirit of co-operation, readily cut down their requirements for space in favor of those who had none. Even at that it is a regretable fact that 75 applications could not be granted.

A comparative table follows showing the space used and the number of exhibitors at the conventions during the past 12 years:

Year	Exhibit Space	Number of Exhibits
1910	71,019	...
1911	76,110	245
1912	83,507	262
1913	87,360	277
1914	82,218	266
1916	76,643	258
1917 and 1918	No exhibit*	...
1919	93,499	314
1920	100,061	365
1921	No exhibit†	...
1922	96,000‡	341

*No exhibit because of war.
†No exhibit because of cancellation of convention.
‡Balcony not used this year because of poor location.

Among the list of exhibitors those which are of special interest to electrical men are as follows:

List of Exhibitors

Black & Decker Mfg. Co., The, Baltimore, Md.—Portable electric grinder; portable grinder; portable elec-

tric drill; electric valve grinder; electric screw driver; bench drilling stands. Represented by R. D. Black, H. G. Smith and G. R. Lundane. Space 217.

Clark Tructractor Co., Buchanan, Mich.—Clark Truklift; tractor model of Clark Tructractor. Represented by Louis J. Schneider, A. C. Rampell and W. B. Eldred. Space 137.

Edison Storage Battery Co., Orange, N. J.—Storage battery cells cut away to show parts and construction; maps showing railroads using Edison batteries; car lighting battery box with installation of Edison batteries; model of Railway Storage Battery car; seven-cell battery for signal service; five-cell battery for portable lighting; three, four and five cell batteries for car lighting. Represented by F. D. Fagan, D. B. Mugan, A. S. Knox, D. C. Wilson, Paul Sutcliffe, R. Baird, W. F. Bauer, W. W. Coleman and J. A. Cassedy. Space 636.

Electric Arc Cutting & Welding Co., Newark, N. J.—Rivet cutting apparatus; welding and cutting apparatus; electrodes; supplies. Represented by C. J. Holslag, J. E. Gunning, J. I. Mitchell and E. J. Knapp. Space 37.

Electric Controller & Mfg Co., Cleveland, Ohio.—E. C. & M. control, consisting of push button operated automatic starting compensators and across-the-line starting switches, with thermal overload relays; direct-current automatic starters and machine tool controllers, contactors, relays, etc. Represented by R. G. Widdows and H. K. Hardcastle. Space 85.

Electric Service Supplies Co., Philadelphia, Pa.—Golden Glow locomotive headlights, reflectors and flood lights; Keystone turbo-generators, headlight switches, classification and marker lights, gage lights, rear tender lights and roundhouse lighting fixtures. Represented by Charles J. Mayer, A. H. Englund, J. W. Porter, J. R. McFarlin, L. A. Darling, T. M. Childs, W. H. Smaw and H. J. Graham. Spaces 312-314.

Electric Storage Battery Co., Philadelphia, Pa.—Exide body hung axle light equipment with Exide Battery in operation; Exide batteries "A" and "B" for railway signal service, industrial trucks, starting and lighting equipment for automobiles, and radio service. Represented by H. B. Marshall, J. L. Woodbridge, T. L. Mount, F. G. Beetem, H. E. Hunt, R. I. Baird, H. M. Beck, W. C. Hooven, George Hayes, H. S. Mills, M. C. Pope, Jr., A. W. Pierce, P. G. Downton, L. E. Lighton and H. W. Beedle. Space 624.

Elwell-Parker Electric Co., Cleveland, Ohio.—Type CK crane platform truck; TL tractor; EG elevating platform truck; truck power plant; Elwell-Parker combination trailer-platform. Represented by Lucian C. Brown, George W. Brown, Charles C. Dietz, W. C. Kershaw, C. E. Cochran, F. B. Neely, R. C. Howell, C. B. Cook and J. M. Brown. Space 341.

General Electric Co., Schenectady, N. Y.—Various applications of industrial control apparatus in operation; semi-automatic electric arc welding equipment in operation. Represented by J. G. Barry, E. P. Walter, F. S. Hartman, A. H. Armstrong, C. K. West, John Roberts, C. Dorticos, W. J. Clark, C. F. Lawrence, R. S. Bennett, J. J. Liles, D. K. Frost, C. H. Williams, F. P. Jones, L. W. Shugg, P. O. Noble, R. D. Reed, C. W. Kenyon, John Eaton and C. C. Pierce. Spaces 119-121-123-125-127-129.

Gould Coupler Company, New York.—Couplers; truck bolsters; truck side frames; journal boxes, slack adjusters; friction draft gears; electric car lighting equipment with batteries; locomotive headlight generator. Represented by Charles A. Gould, W. F. Richards, W. F. Bouche, G. B. Young, W. B. Osborne, M. R. Shedd, D. C. Davis, G. R. Berger, G. F. Collins, C. W. Gould, W. H. Sauvage, J. W. Reifsnyder, H. C. Johnstone, P. H. Simpson, William Garstang, W. L. Kraemer and F. J. Beard. Space 221.

Howell Electric Motors Co., Howell, Mich.—Polyphase induction motors; sectional motor showing detailed construction. Represented by Charles F. Norton, H. N. Spencer and O. A. Reed. Space 161.

Kerite Insulated Wire & Cable Co., The, New York.—Insulated wires and cables. Represented by B. L. Winchell, Jr., Azel Ames, P. W. Miller, J. W. Young, J. A. Renton, R. E. Butrick, W. H. Fenley, E. L. Adams, J. A. Hamilton and Carl Reeb. Spaces 523-525.

Loco Light Company, The, Indianapolis, Ind.—Headlight turbo-generator in operation; headlight case. Represented by H. H. Tomlinson. Space 202.

Main Belting Co., Philadelphia, Pa.—Complete car lighting belt, belting and belt fasteners. Represented by H. W. Lnydall. Space 234.

Mercury Manufacturing Company, Chicago.—Mercury twin-three tractor; Mercury freight house trailer; motion pictures of "The Trackless Train" operating in railroad passenger and freight terminals. Represented by C. H. Clare, J. S. Kumkle and L. J. Kline. Space 404.

Okonite Company, The, Passaic, N. J.—Rubber covered wires and cables for railroad service; varnished cambric covered wires and cables; insulating tapes. Represented by W. R. Van Steenburgh, F. J. White and J. D. Underhill. Space 538.

Oliver Electric & Manufacturing Co., St. Louis, Mo.—Plugs and receptacles; train line connectors; headlight switches; tender signal lamps; portable hand lamps; cab light fixtures; classification and marker lamps; flexible conduit couplings; safety-first switches; miscellaneous wiring devices; terminal and junction boxes. Represented by J. A. Amos and W. A. Ross. Space 316.

Otis Automatic Train Control, Inc., Spokane, Wash.—Automatic train and speed control; automatic brake setting valves and train line on small engine; ramp for operating brake setting valves automatically. Represented by A. F. Gammond, John T. Dickinwon, A. L. Gasche, George Schweitzer and R. C. Miller. Space 706.

Page Steel & Wire Co., Bridgeport, Conn.—Page Armco welding rods and electrodes; Page Armco signal bond wires, line wire and strand; wire mesh for refrigerator car construction; panel partitions for store and stock rooms. Represented by W. T. Kyle, C. A. McCune, W. H. Bleecker and E. L. Schaeffer. Spaces 305-307.

Pyle-National Company, Chicago.—Turbo-generators; cast aluminum cases, complete with reflectors and focusing devices; Armco iron headlight cases; back-up lamps; steam turbine; 10-in. portable lamp; switch en-

gine headlight case; adjustable flood and searchlights; fan; Nonglare and crystal glass reflectors; 10-in. flood light. Represented by R. C. Vilas, J. Will Johnson, William Miller, T. P. McGinnis, Crawford P. McGinnis, George E. Haas, R. L. Kilker, L. H. Stager and Walter Smith. Spaces 602-604-606.

Regan Safety Devices Co., Inc., New York.—Regan automatic train control devices; animated technical drawings of the train control devices. Represented by J. Beaumont and F. J. Lepreau. Space 402.

Roebling's Sons Company, John A., Trenton, N. J.—Gas and electric welding wire; steel and copper telephone and telegraph wire; bond wires, etc.; wire rope from 1/32-in. to 3¾-in. diameter, of various constructions; wire rope fittings; wire rope slings lifting a model locomotive; bell or signal cord; wire cloth for spark arrester, window screening, etc.; insulated wires and cables; induction coils. Represented by H. E. Thorne, A. E. Gaynor, L. Unsworth, Mr. Nolan, A. W. Miller and E. A. Bertram. Space 134.

Safety Car Heating & Lighting Co., New York.—Car lighting equipment (electric and Pintsch); batteries and lighting fixtures; electric fans, water coolers and water heaters. Represented by W. L. Conwell, W. L. Garland, J. H. Rodger, R. H. Harvey, S. I. Hopkins, H. D. Donnell, A. B. Mills, H. K. Williams, G. Scott, J. H. Henry, L. W. Shipley, G. E. Hulse and L. Schepmoes. Aquarium Court.

Standard Electric Crane & Hoist Co., Phialdelphia, Pa.—New type of short-headroom monorail electric hoist of two to three tons' capacity. Represented by H. S. Valentine, E. C. Roop and P. G. Basehore. Space 73.

Stone-Franklin Company, New York.—Standard single battery car lighting equipment (running exhibit); detail parts of equipment. Represented by R. G. Coburn, J. L. Hays, C. E. Walker, W. L. Gray, H. D. Rohman, R. E. Gallagher and R. Gerrard. Space 406.

Sunbeam Electric Mfg. Co., Evansville, Ind.—Turbo-generator; standard locomotive headlight; cast metal headlight; cast metal cab lamp fittings; Sunbeam air-tight headlight. Represented by F. W. Edmonds, W. T. Manlogue and J. Henry Schroeder. Spaces 321-323.

U. S. Light & Heat Corporation, Niagara Falls, N. Y.—USL car lighting equipment; carlighting generator with shaft drive; USL Plante type storage battery; USL regulator panel; USL 200 and 300-ampere portable arc welders. Represented by H. A. Matthews, W. L. Bliss, W. A. Turbayne, E. Bauer and O. R. Hildebrant. Space 338.

Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.—Portable arc welding outfit in operation; turntable equipment in operation; locomotive headlight generator and parts; overhead line material; drum controllers; automatic starting panels; motor starting switches; industrial lighting exhibit. Represented by C. C. Bowden, A. M. Candy, W. F. Cargo, F. W. Carter, B. L. Clegg, S. B. Cooper, J. L. Crouse, A. L. Harvey, O. W. Hershey, H. A. Houston, H. D. James, A. M. Jones, C. R. Jones, G. T. Keetch, R. H. Kilner, E. D. Lynch, W. R. Marshall, J. C. McQuiston, Paul Orr, L. C. Paul, L. N. Reed, W. W. Reddie, R. J. Ross, E. F. Sells, W. R. Steinmetz, N. W. Storer, A. D. Turner, E. M. Wise and F. E. Wynne. Spaces 21-23-25-27-29-96-98-100.

Willard Storage Battery Co., Cleveland, Ohio.—Standard two-compartment unit in rubber jars, with parts; special panel showing plate details; railway signal cells, sealed glass and hard rubber jar types; radio "A" and "B" batteries. Represented by A. E. Harrold and Louis Sears. Space 34.

Standardization Rules for Electric Arc Welding Apparatus*

1. Purpose and Plan of Rules

The purpose of these rules is to provide standards for use in connection with specifications for, and the purchase, sale and use of, arc welding apparatus.

2. Classification

For the purposes of convenient designation arc welding apparatus shall be considered to be of three general classes:

(a) *Generator or Motor Generator Class.* This class includes, special generators driven by prime movers, special generators direct connected to electric motors, converters and dynamotors.

(b) *Transformer Class.* This class refers to special transformers connected to a source of alternating power, the secondary circuit of which supplies the arc or arcs.

(c) *Rheostat or Reactor Class.* This class includes the type of equipment which is connected directly to the source of supply, the voltage being reduced by means of a rheostat or reactor to the proper value for the arc or arcs.

Definitions

3. *Arc e.m.f.* is the total e.m.f. between the electrode and base metal.

4. *Arc stream e.m.f.* is that portion of the arc e.m.f. that varies with the length of the arc.

5. *Electrode e.m.f.* is that portion of the arc e.m.f. that depends upon the character and condition of the electrode.

6. *Open circuit e.m.f.* of a welding circuit is the e.m.f. when no current is flowing.

7. *Time of recovery* is the time required to assume conditions to within 5 per cent of their final value in an automatically regulated welding circuit after a definitely specified disturbance has taken place. The time of recovery of a constant-current machine is measured as follows: Insert resistance in the welding circuit of such value that normal full-load terminal voltage of the machine is registered across it at full-load current; short-circuit one-half of the resistance and allow conditions to become stable; then instantly remove the short-circuit. The time required for the current to return to within 5 per cent of its original value is the time of recovery. The time of recovery of a constant-potential machine is measured as follows: Insert resistance in the welding circuit of such value that full-load current is registered at normal full-load voltage; short-circuit one-half of the resistance and allow conditions to become stable; then instantly remove the short-circuit. The time required for the voltage to return to within 5 per cent of its original value is the time of recovery.

*Report to the American Bureau of Welding submitted by its Committee on Standards for Arc Welding Apparatus. Wherever reference is made to A. I. E. E. standards, the numbers refer to the 1921 edition of the Standards of the American Institute of Electrical Engineers.

8. *Closed-Circuit Arc System* is one in which the circuit is normally closed and the arcs are extinguished by paralleling them with a low-resistance circuit.

9. *Open Circuit Arc System* is one in which the circuit is normally open and the arcs are extinguished by separating the electrodes.

10. *Constant e.m.f.* welding source is one that automatically maintains its e.m.f. within 5 per cent of the full-load setting over the range from full-load to no-load and has a time of recovery of not more than 0.3 second.

11. *Constant Current* welding source is one that automatically maintains its current constant within 5 per cent of its rated capacity over the range of welding voltage, allowing from 15 to 25 volts per arc, and has a time recovery of not more than 0.3 second.

12. *Constant Power* welding source is one which, when adjusted to give rated power output with an arc voltage of 20, will automatically maintain this power output within 5 per cent of the rated value, with variations in arc voltage of 10 per cent above or below 20 volts, and has a time of recovery of not more than 0.3 second.

13. *Variable e.m.f.* welding source is one in which the e.m.f. reduces as the current increases, but not in such a way as to qualify as a constant-energy source.

14. *A Weld* is a solid union of metallic pieces formed by either heating to a fluid state the edges of the pieces to be joined and allowing the metals to flow together (with or without additional molten metal being supplied) without any pressure being supplied or by uniting or consolidating by hammering or compressing with or without previous softening by heat.

15. *Base metal* is the material in a weld which composes the pieces to be united by the weld. Unless otherwise expressly stated, it will be understood that a weld joins two pieces of identical material.

16. *Weld metal* is the material in a weld which has been used in forming the weld. It may consist entirely of the base metal adjacent to the weld or of the material added to the fused base metal from a welding rod or electrode or other material.

17. *Filling metal* is the metal added during the welding process to form part of the weld. In carbon-arc or gas welding it is supplied by means of a *welding rod,* in carbon arc by a *filling rod* and in metal arc welding by the *electrode.* (Note—In some cases in metallic arc welding it may be supplied by both *electrode and filling rod.*)

18. A *test weld* refers to a sample of welding which has been performed under known conditions and upon which tests are to be made.

19. A *test specimen* is a prepared piece from a test weld on which a test is to be made.

100. Selection of Arc Welding Apparatus

The following information relative to the apparatus which it is proposed to supply and the conditions under which it is expected to use such apparatus is to be furnished by the prospective supplier of the apparatus and the prospective purchaser respectively.

(a) *By Prospective Supplier*

1. Rating of apparatus, the rating to be defined as in A. I. E. E. Rule 3508.
2. Number of arcs that can be operated at one time.
3. For A.C. power supply (regardless whether welding apparatus is A.C. or D.C.) maximum momentary kilo-volt-ampere demand, power consumption and power factor at normal rating. For D. C. supply maximum momentary power consumption and power consumption at normal rating.
4. Efficiency as defined in A. I. E. E., Rule 3514, and measured in accordance with Rule 102, given below.
5. Weight, dimensions and portability.
6. Maximum voltage variation permissible at the power supply terminals without causing unsatisfactory operation either momentarily or continuously.
7. Method of regulating current and the number of steps available.
8. Current and voltage characteristics of the apparatus.
9. List of accessories and attachments.

(b) *By Prospective Purchaser*

1. Kind of electric power available, i.e., D. C. or A.C.
2. If supply is A.C., give frequency and number of phases.
3. Voltage of supply circuit.
4. Normal fluctuation of voltage (and frequency if A.C.) of supply circuit at the point where the proposed apparatus is to be connected.
5. Regulation of circuit at point at which proposed apparatus is to be connected, that is, the drop in voltage per 100 k.w. line load.
6. If no source of electrical power is available, give information in regard to the kind of mechanical power that is available for driving a special generator.
7. Apparatus to be portable or stationary.
8. Number of arcs required.
9. Supply of experienced welders.
10. General class of work to be welded.

Tests

101. *Temperature Rise.*—The temperature rise of any part of the apparatus after operating one hour at rated output shall not exceed the limits prescribed by the Standardization Rules of the A.I.E.E. for that class of apparatus when measured in accordance with those rules. The full rated output should be maintained continuously for one hour by means of a suitable resistance.

102. *Efficiency.*—(a) *Input-Output Method.* The efficiency shall be taken as the ratio of the power output to the power input after operating one hour continuously at the rated output with an ambient temperature not exceeding the limits prescribed by the A.I.E.E. for that class of insulation. Average of several readings taken at the end of the one hour run shall be used. The power output shall be measured at the machine terminals to which the arc circuits are connected and the power input shall be measured at the machine terminals which are connected to the source of supply.

(b) *Conventional Efficiency.* The conventional efficiency of an electric machine or apparatus is the ratio of the output to the sum of the output and the losses, or of the input minus the losses to the input, when, in either case conventional values are assigned to one or more of these losses. The conventional efficiency shall be measured as provided in the standardization rules of the A.I.E.E.

Radio Waves and Ripples from Atlantic City

Who We Saw with Who on the Boardwalk and Around the Exhibition Booths at the June Conventions

HELLO-hello-h-e-l-l-o. One, two, three, four, five, six, seven—This is station WYP testing—Hello-hello-hello—Station WYP. Young's Million Dollar Pier, Atlantic City, New Jersey—testing. We are about to broadcast for the benefit of those who couldn't get to the convention some points of information concerning the doings of those that did get here. We have kept pace with the recent remarkable improvements in wireless transmission and have accomplished some truly wonderful results, not only in long distance transmission of speech, but in the transmission of pictures as well.

Ed. Wray and Charlie Quinn

So great has been the improvement in this respect that we can assure everyone who receives this broadcast that he will be able to get the pictures just as well as the speech. Just set your picture receiving equipment in the usual manner and you will be sure to get good results; if you don't, you can be certain there's something wrong with your receiving apparatus.

First of all we want to make sure that those of you away off are hearing us all right so we will call a few—

Ed. Jansen, Electrical Engineer of the Illinois Central

Hello 9 BZY—Hello 9 BZY—Hello 9 BZY—Station WYP calling 9 BZY—come in, old man, come in.

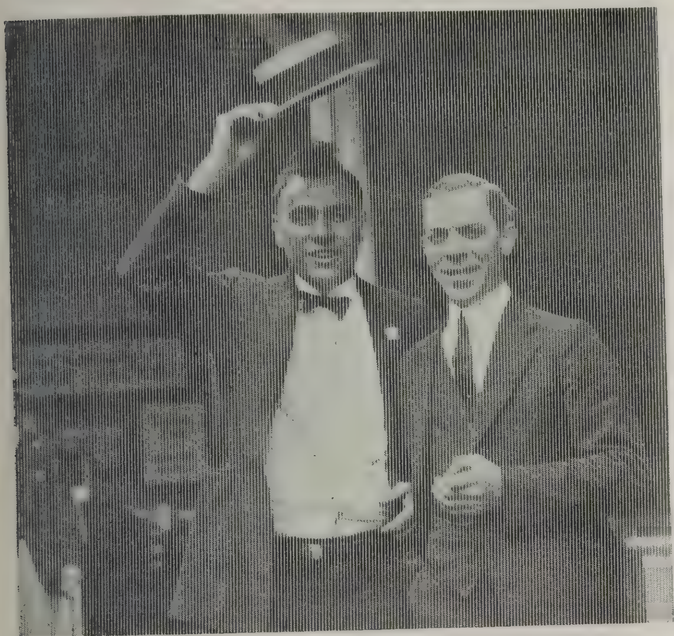
Station 9 BZY Chicago answering WYP. Hear you fine, old man, couldn't be better. Got my picture receiver working first class, too. Anxious to hear what you've got to say. Station 9 BZY signing off.

All right 9 BZY—glad to know we are coming through so well. Now we'll try real long distance test—Hello 6 AUS—Station WYP calling 6 AUS. Come in, old man, come in.

This is station 6 AUS San Francisco, California, answering station WYP. You're coming through very QSA, old man. With my loud speaker on two stages, I can hear you all over the room.

All O. K. All O. K. 6 AUS. That's fine. If you can get us as good as that the rest of the fellows listening ought to be receiving us in great shape so we'll be getting along with our story.

The first thing you fellows want to know is who was there. Well, we can say that there were a lot of folks on hand sure enough. We saw and talked with no small number but I dare say in so vast a throng we may easily have missed a few.



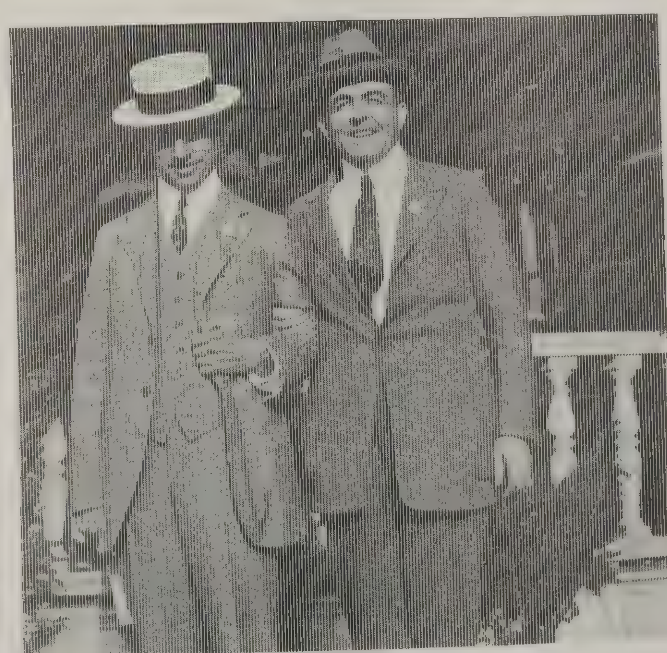
C. J. Holslag of the Electric Arc Cutting & Welding Co. and C. A. McCune of the Page Steel & Wire Co.

About the first people we saw walking around and taking in the scenery was Ed Wray and Charlie Quinn. Ed Wray, you know, was the fellow who started the *Railway Electrical Engineer* way back in the years before the war. Yes, he looks just about the same—don't change much. Here comes his picture—look him over for yourselves. C. H. Q. is standing along with him and what do you think—yes, really and truly—nobody called him on the telephone while we were taking his picture.

Charlie Quinn and C. P. Kahler, Electrical Engineer of the Oregon Short Line

A Mixed Bunch. From Left to Right, A. S. Knox, Edison Storage Battery Co.; Al Prettyman, Grand Central Terminal; P. J. Callahan, Boston & Albany; Frank Zimkowski, New Haven; Bill Gunn, Edison Storage Battery Co.

The electrical men were on hand early and appeared often, and it wasn't long before we got a chance to take a shot at Ed Jansen. You know, Ed is the electrical works on the Illinois Central and he sure is some busy guy these days. You know, they've got a real honest to goodness electrical department on the Illinois Central. You ought to know something about that 9 BZY. If Ed



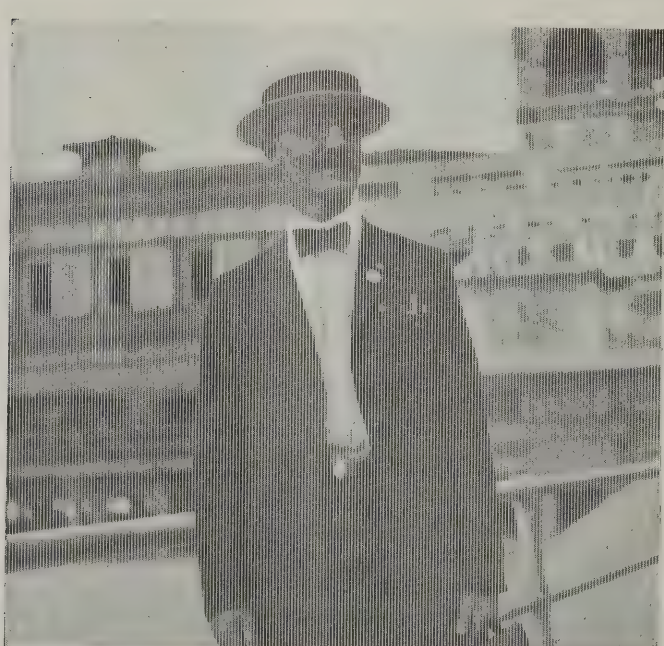
W. L. Allison of the American Arch Co. and W. J. Bohan of the Northern Pacific

loses much more hair, he's going to have a hard time to part it at all.

A little later we found Holslag explaining a marvelous new method of blowing-off rivet heads with his arc welding—what's that—Who is Holslag? We thought everybody knew him. He's the fellow who designed the alternating current welding machine—the Electric Arc Cutting & Welding Co. make 'em. No, he's not quiet and reserved, oh, no—in fact when you hear noises in the

Joseph A. Andreucetti, Asst. Electrical Engineer of the Chicago & North Western

distance that sounds as if your loud speaker had gone wrong, you can be pretty sure it's Holslag. Just about the time we caught up with him Charlie McCune of the Page Steel & Wire Company came along and we took a picture of the two together. You know Charlie is president of the American Welding Society. He isn't so very



J. R. Sloan, Chief Electrician, Pennsylvania System

big physically but he's got a big job. You can see from the picture both of them were feeling pretty well. Maybe they were thinking of the wonderful opportunities in the

L. C. Muelheim, Chief of Headlight Department, Baltimore & Ohio

railroad field for the development of a.c. arc welding and the sale of welding wire—you never can tell.

Out on the boardwalk we ran across Quinn again. This time he had C. P. Kahler, Electrical Engineer, Oregon Short Line with him. Kahler was a little inclined to be camera-shy but C. H. Q. has got used to having his

Walter Kershaw of the Elwell-Parker Electric Co.

picture taken and the power of his influence and ours was too much for C. P. K. to resist. Incidentally, it looks as if Quinn was packing a gun in his right hand coat pocket, but we can't recall that he said he was looking for trouble. At any rate his face doesn't look very vicious.

A little further along we ran across a bunch that are getting to be famous for the way they hang together. They were A. S. Knox and Bill Gunn of the Edison

Storage Battery Co., together with Al Prettyman, Grand Central Terminal, P. J. Callahan, Boston & Albany, and Frank Zimkowski of the New Haven. Prettyman, you know, is a car lighting expert as are also Callahan and Zim, only they have added to their worries the care of

H. W. Pinkerton, Asst. Engineer, New York Central

headlight equipment while Al doesn't have to stew about that. We always find this crowd together every year at Atlantic City and as each one knows he is handsome we never have any trouble in getting their pictures.

Right in front of the pier entrance we halted an illus-

Representatives of the Sunbeam Electric Co., J. Henry Schroeder and W. T. Manogue

trious couple and pressed the button. Note the man on the right and observe how his general appearance indicates position and prosperity. He is W. J. Bohan, Assistant General Mechanical Superintendent of the Northern Pacific, and if that isn't enough, he's one of the vice presidents of the International Railway Fuel Association too. You might never think it but he used to be an electrical engineer before he graduated. So cheer up, fellows, there's still hope for you all. The other fellow with Bohan is W. L. Allison of the American Arch Company; got his start on the Santa Fe.

Our next victim was our old friend Joe Andreucetti—smiling and looking like a million dollars with his sport cane. We got him before he got too busy with the convention affairs and as you can see he isn't worried about the prospects at all. Things went off pretty smoothly this year under Joe's guiding hand, for you know while presidents of the Association of Railway Electrical Engineers come and go, our friend Joe, like the brook, goes on forever. It's a good thing he does for he knows the ropes and keeps new officers from falling into many parliamentary pitfalls. Yes, we would have a hard time to get along without Joe.

J. R. Sloan, chief electrician of the Pennsylvania Sys-

L. S. Billau, Asst. Electrical Engineer, Baltimore & Ohio

tem, was wandering along the boardwalk towards his hotel when he ran afoul of our ever watchful eye and it wasn't but a matter of a few seconds before we had him recorded on the film. The outstanding feature of this picture, as those of you who know him best will probably notice is the absence of his dear old pipe. It may be he slipped it into his pocket when he saw us coming—of this we can't be sure. J. R. is a busy man at convention time. It's a hard proposition to play on two teams at once, although that is what J. R. has to do as chairman of the committee on Train Lighting and Equipment. First the report is presented to the Mechanical Division of the American Railway Association and then served up to the electrical men of the A. R. E. E. But J. R. seems to get away with it very successfully. He sends a written discussion to one meeting and appears in person at the other. There are many who are hoping that this duplicate presentation of reports will be eventually relegated to the scrap heap of defunct practices.

The next man we ran across was L. C. Muelheim, who is chief of the headlight department on the B. & O. From the appearance of the bulky envelope he carries we suspect he had been out among the exhibits gathering all sorts of useful literature. You see he carries a cane also which shows he has the sportive instinct, although we doubt very much if he ever wears it away from Atlantic City.

Then we met Walter Kershaw who was boss of the car lighting activities at Sunnyside yard of the Pennsylvania R.R. for so long. All the car lighting fellows have either heard of Walter or know him personally. No, he doesn't work there any more—he's with the Elwell-Parker Electric Company and if you don't watch out he will sell you an electric truck or tractor before you know it. Walter covers a lot of ground in his travels from the frozen north of a Canadian winter to the sunny south of Florida, but he always shows up at convention time.

It's the greatest wonder in the world that we got a picture of H. W. Pinkerton, Assistant Engineer, New York Central, at all. One has to work fast when he tries to follow him around. He usually gets to the conventions, but he is some lively guy—he appears and then disappears in almost no time at all. We are forced to marvel at the wonderful manner in which he is able to absorb all of the exhibit in about an hour and a quarter,

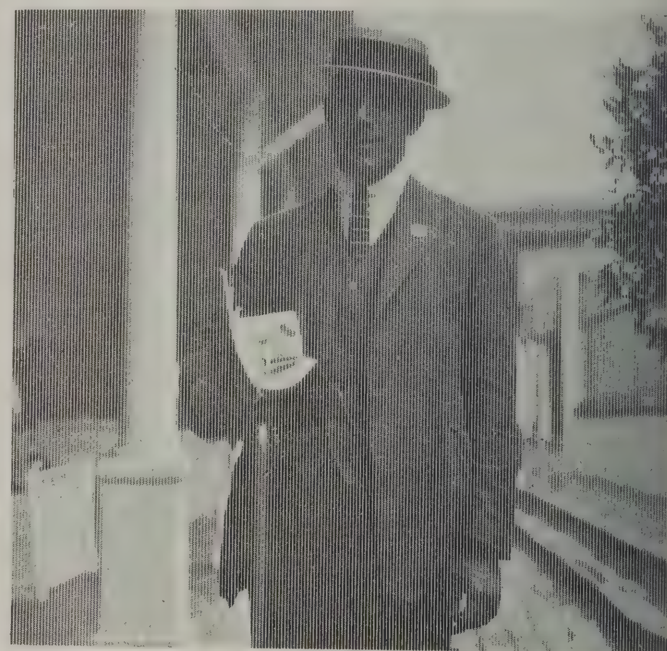
Four Representatives of the Westinghouse Electric & Mfg. Co. From Left to Right, H. A. Huston, N. W. Storer, W. R. Stinemetz, Q. W. Hershey

and the only way we can account for it is that he invariably travels by himself. H. W. P. doesn't let any grass grow under his feet.

We found out we weren't the only people taking pictures when we ran into J. Henry Schroeder and W. T. Manogue of the Sunbeam Electric Company. At any rate, J. Henry was toting a case along and we assume it contained a camera, although we are bound to admit we did not see him taking any pictures. He and Manogue look very cheerful, which is natural enough when you consider that they are dealing in sunbeams.

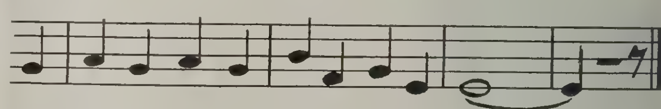
Then there was L. S. Billau, Assistant Electrical Engineer of the B. & O. Billau didn't linger very long at the convention this year either, although he found time to pose for a picture. You see him holding up a copy of the *Railway Electrical Engineer,* and we are not quite sure whether he did this to tickle our vanity or to give added publicity to the advertiser on the front cover. It is nevertheless significant that L. S. B. finds the *Railway Electrical Engineer* useful in his business and naturally enough we like to know it is appreciated.

The next — — — —Splut—splut—splutter—snap—hiss



E. S. M. MacNab, Electrical Engineer of the Canadian Pacific

—hiss—Sounds as if someone else was trying to get in on our wave length—Everything's been going so fine we almost forgot we were broadcast—Hiss—hiss—splutter —splutter—Aha, we thought so—



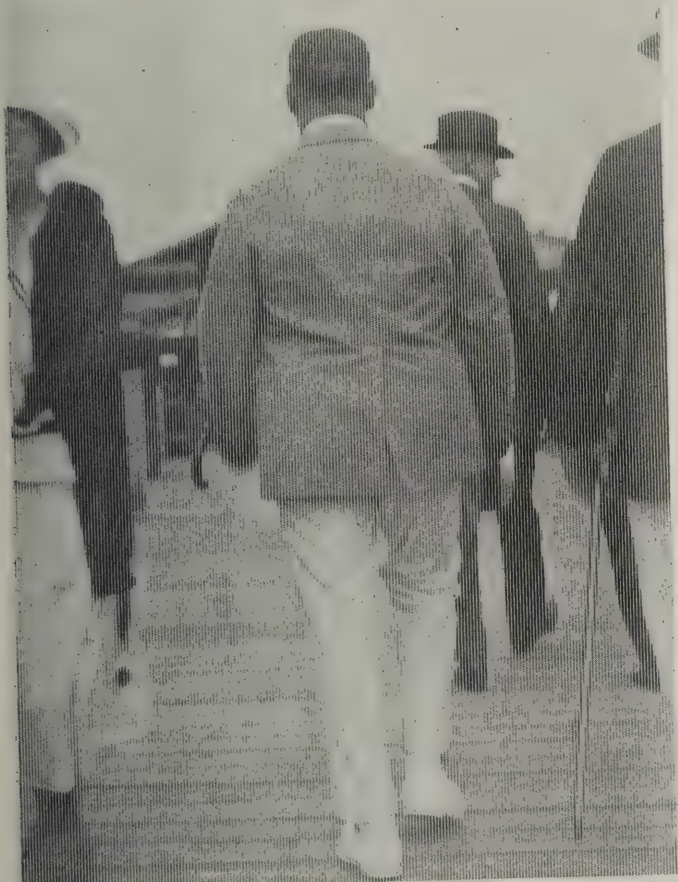
This concludes our program. From time to time we desire our radio audience to write to us. We are being heard at great distances from this station and we should like to know how you receive our programs. Criticisms are welcome. Write to us from far and near. This is station WJZ, the Radiophone Broadcasting Station of the Westinghouse Electric & Manufacturing Company located at Newark, N. J. We are signing off. Good evening.

That sounds just like announcer A. W. N., although he didn't say so. But this reminds us that we have a picture of some of the Westinghouse crowd among our collection, although we feel pretty sure that these men don't have much to do with the radio telephone part of their company's activities. Here's an impressive group of four of them—H. A. Huston, N. W. Storer, W. R. Stinemetz and Q. W. Hershey. You will note that Stinemetz and Hershey don't have to worry much about the increased prices announced recently by the tonsorial parlors. We dare not say that one can't have hair and brains 'cause the other two chaps probably have lots of both. At any rate, they were generous enough to present themselves to the mercies of the photographer much as they present information on electrical equipment to the railroads.

Then there was E. S. M. MacNab, Electrical Engineer, Canadian Pacific. You know he had to officiate at the

convention on account of the absence of Lou Hensel, who didn't get around at all. We are sorry Hensel didn't show up but we must commend Mac on the excellent manner in which he presided over the meeting of the electrical men. You might not think it to look at him that Mac was camera-shy, but he is just the same. Some time ago we wanted to get his photograph as one of the officers of the A. R. E. E. but we nearly despaired of getting it before it arrived. However, he didn't kick very much about posing for the present one. You can see Mac believes in doing as the Romans do—wears a soft collar, carries a cane, an' everything.

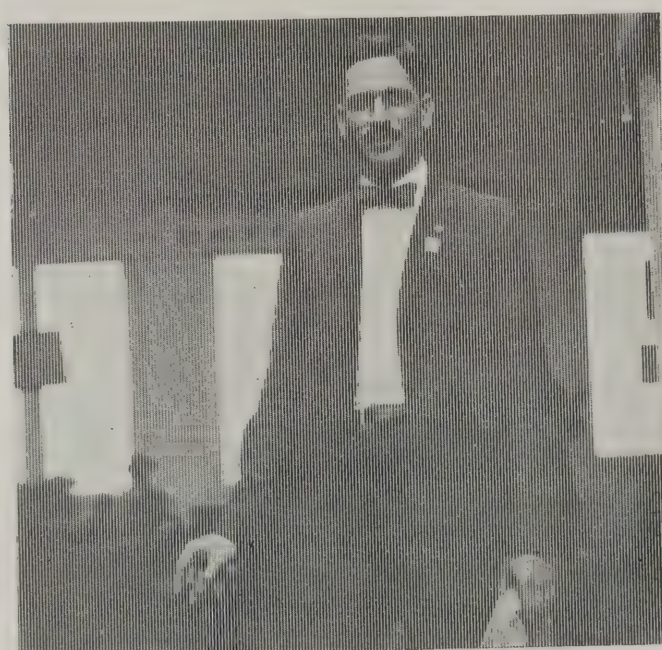
Next we came to another group of fellows—three railroaders and one supply man. These were W. W. Leonard, of the B. & O.; C. W. T. Stuart, of the Pennsylvania; G. W. Bebout, Shop and Electrical Engineer C. & O., and J. L. Marsh, of the Safety Car Heating & Lighting Company. Everybody who has ever read the *Railway Electrical Engineer* knows Stuart, who has acquired considerable fame as a contributor of car lighting articles, to say nothing about his creation of the well known characters of Hinkee Dee and Jimmie Goat. The last time we were down in Baltimore to see Leonard we nearly died with the awful heat they have down there, so we haven't dared to go again but some day we hope to get up courage enough to pay him another visit. We suspect Jimmie Marsh had been trying to extol the virtues of the Safety equipment to these car lighting sharks. We can't say much concerning Bebout as he has not passed through our orbit very often in the past and we don't know him as well as we should like to. However, we are bound to observe that the cares of railroading have not subdued his cheerful spirit.



The Stalwart Vice President of the Stone-Franklin Company, Inc. H. D. Rohman, Leaving Us Behind

Common Interests Brought This Group Together. From Left to Right, W. W. Leonard, J. L. Marsh, G. W. Bebout, C. W. T. Stuart

It was getting along towards eleven o'clock when we went out to the end of the pier to see the fish nets drawn in. There it was that we saw this broad shouldered, husky looking chap. Very likely most of you fellows recognize him just as well from the rear as from the front, but for those that are not sure we will say that he is Harry B. Rohman, vice president and chief engineer of the Stone Franklin Company, Inc. We wondered why he seemed to be in such a hurry to get away but later we found out when he confided to us that each day at that time he made it a point to take a dip in the waves. Gosh,



H. W. Lyndall, Mgr. of the Car Lighting Department of the Main Belting Co.

how we envied him that opportunity. We have our greatest fun with H. D. R. by taking his photo unawares. He never saw this picture of himself until right now. We got a picture of Jim Hays of the some company, too, but it wasn't a bit complimentary, and at his earnest request we agreed to suppress it.

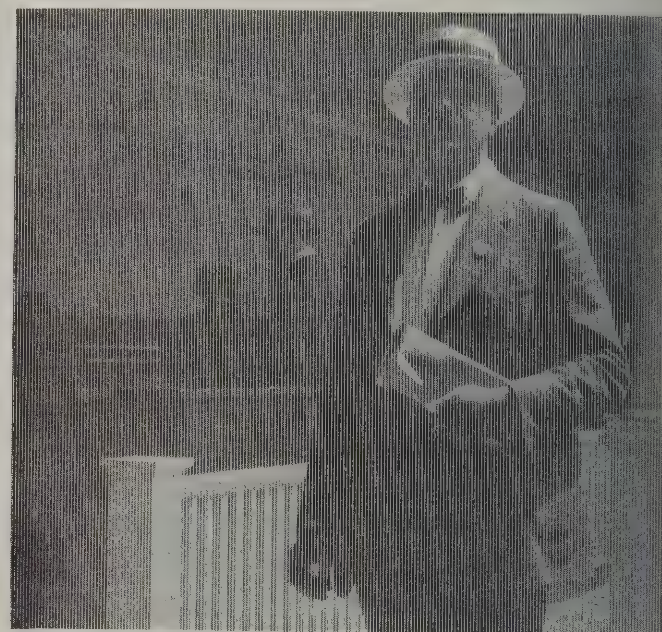
The next picture we are going to show you is that of a very tall, good looking chap—H. W. Lyndall, Manager of the Car Lighting department of the Main Belting Company. Unfortunately in presenting his portrait we had to cut down so much of his height that it's hard to appreciate how tall he really is. Luckily his exhibits did not require much space so there was still plenty of leg room when he sat down. We feel sure he would have a hard time in driving a flivver.

Further out on the pier we rounded up an imposing group of representatives of the Electric Storage Battery Company—ten E. S. B. men and one railroad man, F. J. Hill, chief electrician of the Michigan Central. He's the fifth one from the left. Just so you can tell who they are—the names from left to right are H. E. Hunt, W. V.

Group of Representatives of the Electric Storage Battery Co. From Left to Right, H. E. Hunt, W. V. Brandt, T. L. Mount, H. W. Beedle, F. J. Hill, Michigan Central, W. C. Hooven, M. C. Pope, Jr., George Hayes, L. E. Lighton, Howard S. Mills, H. S. C. Folks

Brandt, T. L. Mount, General office; H. W. Beedle, Boston Branch; F. J. Hill, Michigan Central; W. C. Hooven, Philadelphia branch; M. C. Pope, Jr., Washington branch; George Hayes, New York branch; L. E. Lighton, Detroit; Howard S. Mills and H. S. C. Folks, New York branch. These are some of the fellows who carry some of the responsibility of selling the E. S. B. products. We are sorry that J. Lester Woodbridge, the chief engineer of the company did not get in the picture. J. Lester, you know, is a studious reader of the *Railway Electrical Engineer,* and doesn't hesitate to say so when he doesn't exactly agree with us. Mrs. Mount wouldn't step into the picture, but there is no question about her being an able representative.

While we are talking about car lighting men we want to show you another bunch—the Safety Car Heating & Lighting Company. We didn't take this picture so of course we can't guarantee that it will be as satisfactory as the others. Those seated from left to right are G. E. Hulse, chief engineer, New Haven; L. S. Henry, Manager Northeastern District, New York; H. D. Donnele, representative at San Francisco; the ones standing are J. H. Rodger, vice president, Chicago; A. V. Livingston, electrical engineer, New Haven; L. W. Sipley, sales engineer, Philadelphia; F. J. Hill, Michigan Central Railroad; J. D. Strobell, assistant engineer, New Haven; R.



F. W. Butt, Asst. Engineer, New York Central

H. Harvey, Manager Canadian District, Montreal; S. I. Hopkins, representative, St. Louis; A. B. Mills, representative, Boston; G. H. Scott, representative, Chicago; W. L. Conwell, President, and L. Schepmoes, manager sales service, New Haven. Notice how our friend F. J. Hill happened to be around at picture taking time.

Safety Car Heating & Lighting Co. From Left to Right, Seated, G. E. Hulse, L. S. Henry, H. D. Donnell, Standing, J. H. Rodger, A. V. Livingston, L. W. Sipley, F. J. Hill, J. D. Strobell, R. H. Harvey, S. T. Hopkins, A. B. Mills, G. H. Scott, W. L. Conwell, L. Schepmoes

Just around the corner from the Safety crowd we found F. W. Butt, assistant engineer, New York Central, and we interfered with his note taking long enough to get his picture. Like Pinkerton, he only stays a short

while at the convention, but he evidently makes the most of it. We can't recall ever seeing Pinkerton's note book, though.

Then we managed to gather together some of the General Electric fellows for a photograph—seven in all—and here they are. From left to right, R. D. Reed, P. O. Noble, F. P. Jones, Jr., D. K. Frost, J. J. Liles, C. Dorticos and J. A. Boers. We don't know all of these fellows as well as we would like to, but we do know something about P. O. Noble. Paul used to go to Penn State College when we did. We never see Paul but what we recall his dad who used to be the preacher at Sunday chapel. I don't think we will ever forget the sermon presented one morning which touched on modern business methods. "The business man of today," said Noble, Sr., "no longer says, 'I now take my pen in hand,' but rather something like this, 'I now take my typewriter on my knee.'" Of course, the old gentleman didn't realize how it sounded, but we are bound to admit his example was up to the minute, to say the least. We wonder if Paul remembers this as we do—probably not, but we wouldn't be surprised if Paddy Goddard did.

General Electric Co. Group. From Left to Right, R. D. Reed, P. O. Noble, F. P. Jones, Jr., D. K. Frost, J. J. Liles, C. Dorticos, J. A. Boers

Howard T. Tomlinson, Vice President of the Loco Light Company

The next picture we present is that of Howard T. Tomlinson, vice president of the Loco Light Company. Howard's erect pose makes us think of military training, but we don't know whether it was West Point, Plattsburg or Annapolis.

A Pyle National Group. From Left to Right, R. L. Kilker, George E. Haas, J. L. Reese, Wm. Miller, Crawford McGinnis

While we are talking about headlight manufacturers we take the opportunity to call your attention to the group of Pyle National men. From left to right they are R. L. Kilker, George E. Haas, J. L. Reese, William Miller and Crawford McGinnis. The one we know best is McGinnis as he very frequently contributes remarks on the convention floor of the A. R. E. E. At the recent

Electric Service Supplies Co. Representatives. From Left to Right, J. R. McFarlin, H. J. Graham, W. H. Smaw

meeting he gave us some interesting figures on locomotive headlight lamp life. We didn't get a chance to take this picture until all of a number of "cash customers" had left the booth and by that time J. Will Johnson had gone also.

The Electric Service Supplies Company was the next group we caught. They make headlights too, you know. They were so busy demonstrating their apparatus that they could hardly find time to let us get their picture, but finally found time to spare a moment. From left to right they are J. R. McFarlan, H. J. Graham and W. H. Smaw.

Gould Coupler Co. Representatives. From Left to Right, M. R. Shed, G. R. Berger, G. B. Young, W. F. Bouche, P. H. Simpson

The next group represents a combination of both headlight and car lighting men—the Gould Coupler Company. From left to right, M. R. Shed, G. R. Berger, G. B. Young, W. F. Bouche and P. H. Simpson. With the exception of Young, this is the same gang that we always meet at the conventions. We discovered this year that Simpson has a fondness for being photographed. By force of circumstances, we had to take a lot of our pictures near the Gould booth, which was located in the open, and you would be surprised to see the number of times friend Simpson's face loomed up in the background. It could truthfully be said that Phil was among those present.

U. S. Light & Heat Corporation Representatives. From Left to Right, W. W. Halsey, Otto Hildebrant, Robert Desmond, W. L. Bliss, H. A. Mathews, Ernest Bauer

Edison Storage Battery Group with One Visitor. From Left to Right, J. A. Cassidy, E. Baird, D. C. Wilson, W. H. Reader (Safety Co.), A. S. Knox, D. B. Mugan

This year we were able to get a photograph of the U. S. Light & Heat Corporation crowd. At recent conventions, prior to this one, they have somehow eluded it, but here they are. From left to right they are W. W. Halsey, Otto Hildebrant, Robert Desmond, W. L. Bliss, H. A. Mathews and Ernest Bauer.

Three Members of the Products Distributing Corporation. From Left to Right, G. C. Lightner, Raymond Hawley, E. M. Fitz

W. L. B. is the one we know the best as he has favored us with problems and solutions for our Question corner. He's a wonder when it comes to writing letters, too. Gosh, what a lot of letters he can write.

Our next group is comprised of some of the Edison Storage Battery boys, but contains a visitor. If you will

note the rather discouraged looking individual the fourth from the left you will see W. H. Reader of the Safety Company. Just why the forlorn look, we are unable to say unless it is—well, at any rate, we can't see why he should look so distressed about it. From left to right

P. M. Arnt, Representative of the Howell Motors Co.

they are J. A. Cassidy, E. Baird, D. C. Wilson, W. H. Reader, A. S. Knox and D. B. Mugan.

Next we have a trio out on the pier. These gentlemen are members of the Products Distributing Corporation which has recently been organized as a selling company

Paddy Goddard and W. F. Bouche

for a direct drive axle generator system. E. M. Fitz, the inventor of the drive, stands at the right. Raymond Hawley is the man in the center and G. C. Lightner the one on the left. The generator designed by E. M. F. is mounted directly on one of the car axles and incidently if there is any significance in his initials, electrically speaking, things ought to move.

The fellow with the newspaper in his hand, standing in the rain, is P. M. Arnt, representative of the Howell Electric Motor Company. It wasn't raining hard enough to spoil his straw hat and Arnt is an agreeable sort of chap who wouldn't kick at a little thing like that anyway.

Our last picture is that of E. E. Goddard, of the Pennsylvania Railroad, and W. F. Bouche, of the Gould Coupler Company. Bouche you saw before, but this is the first you have seen of Paddy Goddard. Not only is Paddy an electrical engineer, but in the years gone by he used to be the leader of a real nice band. He was some musician in those college days of long ago. We could tell a lot of things about Paddy and we dare say he could tell some about us too, but we couldn't send them into the air this way. This concludes the list. "That's all there is, there isn't any more." We would like to tell you about a lot of others but it wasn't humanly possible to see and talk with everyone. We hope you—what's that—a telegram? Just a moment, please. All right, I'll read it.

OAKLAND, Cal.

W. Y. P. Railway Electrical Engineer Broadcasting Station. Young's Million Dollar Pier. Your broadcasting convention received here with wonderful clearness. Have been listening in on home-made crystal set made with safety pin and piece of coal. Have heard every word. J. J. HACK.

All right, Mr. Hack, that's very good news. We must say that Armstrong has nothing on you for long distance reception by simplified means.

And now, radio audience, as all broadcasting programs must come to an end, so must ours. We trust you have all enjoyed our brief summary of folks present. If those we have not mentioned will let us know, we'll try to see they are not overlooked the next time. Good night.

The motor truck has become an active competitor of rail carriers for short haul freight and it is for these carriers to decide whether they shall continue to compete for this class of freight while the motor truck gets the use of state highways free of cost. Edward G. Riggs in an article in a recent number of the Forum has ably summarized the existing conditions, quoted eminent authorities on the subject and tabulated relevant statistics. Mr. Riggs shows the unjust ratios of taxes paid by the two agencies and, although the motor truck is here to stay, points out the trend toward an equalization of transportation taxation.

Hydro-electric Power in Japan.—Much activity is centred in the several hydro-electric power undertakings in Japan which have been under way since 1920. In Japan proper, three operations are planned for, having as their objective the furnishing of power, through three distinct lines of transmission, to the cities of Kobe, Osaka and Kyoto to the south and Yokohama and Tokyo to the north. Utimately the three operations will be merged into one company. Much of the material required for this work, such as transmission towers and cables, will be of American manufacture. Building on a large scale is now in progress. Japan is proceeding steadily with the electrification of its railroads and it is only a question of time when practically every potential water power source will be pressed into service.

General News Section

The Brazilian government has recently negotiated a loan of $25,000,000 in the New York market the proceeds of which will be devoted to electrification work on the Central of Brazil, a government-owned carrier.

The U. S. Light & Heat Corporation, Niagara Falls, N. Y., received about 500 orders for car lighting equipments during May and June from the following railroads: Atchison, Topeka & Sante Fe; Boston & Maine; Chesapeake & Ohio; Chicago, Rock Island & Pacific; Norfolk Southern; Norfolk & Western; Pennsylvania; and Wabash.

The Eleventh Annual Safety Congress of the National Safety Council will be held at Detroit from August 28 to September 1. A number of subjects pertaining directly to steam railroads will be presented and discussed on the mornings of Tuesday, August 29, and Wednesday, August 30. All meetings will be held in the new Cass Technical High School.

The May issue of the South African Railways and Harbors Magazine is devoted to a full exposition of the subject of railway electrification, especially as it applies to South Africa. In addition, some valuable information is given about the railway situation in general in South Africa together with a map of the railways. This magazine is published by the publicity manager of the South African Railways at Doornfontein, Johannesburg.

The Products Distributing Corporation, 360 Madison Avenue, New York, has been organized as a selling company for a direct drive axle generator and system for the electric lighting of railway cars. The equipment will be built by the Wagner Electric Company of St. Louis, Mo., under the E. M. Fitz patents. The generator used with this equipment is of the self-regulation constant voltage type and is mounted directly on one of the car axles.

Automatic train control has been recommended for all British railways. The committee of government and railway officers which was appointed by the British Government in 1920 to report on the subject of automatic train control, the chairman of which was Colonel J. W. Pringle, chief inspecting officer, has presented its report and it was published on June 20. It recommends the gradual adoption of automatic train control on British railways.

Dwight P. Robinson & Company, engineers and constructors with main offices in New York City and branch offices in Chicago, Los Angeles, Montreal, Youngstown, Dallas and Rio de Janeiro, Brazil, has recently entered into a contract with the Metropolitan Life Insurance Company by which life insurance policies are provided without expense to individuals for all members of its organization reporting to the central office under a group insurance plan. This insurance is without cost to the employees and its benefits are in addition to those provided by law under the various State Workmen's Compensation Acts.

The Economy Fuse & Mfg. Company of Chicago, Illinois, announces the appointment of Chas. H. Bluske as district sales manager of the Los Angeles office at 1304 Maltman Avenue. Mr. Bluske was formerly connected with the Pacific States Electric Company of Los Angeles, and succeeds Geo. L. Davis. The Pittsburgh sales office of the Economy Fuse & Mfg. Company has been moved from 2223 Farmers Bank Building to 1006 Peoples Bank Building at Fourth Avenue and Wood Street.

The Swiss Federal Council has decided to fix the amount of the second railway electrification loan at 150,000,000 francs (about $28,713,000 at the present rate of exchange) only, although the first intention was to take up 200,000,000 francs, (about $385,540,840 at the present rate of exchange). The amount subscribed was 280,000,000 francs, (about $53,957,173 at the present rate of exchange). The cause of the reduction of the amount of the loan, which was issued at 4½ per cent, is to be looked for in the expectation that the rate of interest in Switzerland will be further reduced. Electrical locomotives now cost in Switzerland only 500,000 francs (about $96,349 at the present rate of exchange) each as compared with the former price of 900,000 francs (about $173,429).

In connection with the electrification of certain suburban sections of the South Eastern & Chatham Railway, England, a meeting of the shareholders was held recently to approve the proposal. Altogether 220 miles of track extending to a distance of 16 miles out of London are to be converted for electric traction. The scheme having been approved, work is to commence immediately. At the end of May, a company known as the South Eastern & Chatham Construction & Power Company, with a nominal capital of £10,000 in shares of £10 each, was registered for the purpose of undertaking the electrification work and of erecting a generating station. The directors of this company are chosen from the directorates of the South Eastern and the London, Chatham & Dover companies, together with the managing committee's secretary and the general manager of the South Eastern & Chatham Railway.

South African Electrification

A report has been issued by the British Government consulting engineers concerning the electrification of a portion of the railroad from Durban to Glencoe Junction, South Africa. The work now in hand will cost approximately $20,000,000, and will consist of electrifying the line from Pietermaritzburg to Glencoe Junction. The total length of line from Durban to Glencoe Junction is

249 miles and the section which will be electrified includes a little more than two-thirds of the total length of line. Traffic has increased to such an extent as to make electrification urgent on the line from Pietermaritzburg to Glencoe Junction. The line from Durban to Pietermaritzburg, however, is double tracked and electrification of that section is largely an economic question.

It is considered that double tracking from Pietermaritzburg to Glencoe Junction would enormously increase the capacity of the line, but that it is not a remedy for the existing difficulties. Electrification, it is thought, would give practically the same relief as double tracking and in as short a time as if the latter remedy were chosen, and electrification offers additional advantages of improved working conditions and reduced operating costs. By providing for an industrial load at the power station, the administration, or the electricity authority, when appointed, will be able to supply current along the route of the railway for municipal and industrial purposes. The site of the power station has not yet been definitely determined.

Sir William Hoy, general manager of railways and harbors, thinks that the section from Glencoe Junction to Tendega and from Durban to Pietermaritzburg should also be electrified. These sections would entail heavy expenditure in the near future on track improvements if electrification is not adopted. Sir Hoy states also that the electrification will open up great possibilities for by-product production at the power stations from waste coal. The best grade of coal now used for locomotive purposes will, with electrification, be available for shipment, and the coal now regarded as waste will be used for the power stations.

Changes in Westinghouse Personnel

A number of changes in personnel have been announced by the Westinghouse Electric and Manufacturing Company. R. B. Mildon has been appointed general manager of the stoker department, with headquarters at South Philadelphia. G. A. Sacchi, formerly manager of the stoker section of the power department, has been appointed manager of stoker sales and will have his headquarters at South Philadelphia. Edgar Woodrow has been appointed manager of the contract division of the stoker department. F. G. Hickling is now manager of the railway division of the Pittsburgh district office. C. C. Curry, formerly branch manager of the Minneapolis office, has been assigned to special work in connection with the St. Paul Electric Company. Norman Stewart is branch manager of the Minneapolis office. S. R. Shave has been appointed manager of the price section of the power and railway departments, East Pittsburgh. M. C. Rypinski of the radio sales division has transferred his headquarters to New York as a branch of the headquarters sales department. A. Heckman is now works electrical engineer for the East Pittsburgh works of the company. F. R. Kohnstamm has been appointed acting manager of the appliance section of the merchandising department and will be located in Mansfield, Ohio. J. W. Robinson will succeed C. E. Allen as manager of the central station division of the Chicago office. H. A. Lynette has been appointed syndicate representative of the central station division of the Chicago office.

L. C. Bullington, who has been assistant to the manager of the power department for the past several years, has been made assistant manager and will have charge of the general work of the power department. Charles F. Lloyd, formerly manager of the substation section, has been made manager of the electric division and R. E. Carothers, formerly manager of the turbine section, has been appointed manager of the steam division.

The vacancies caused by the promotions of Mr. Lloyd and Mr. Carothers have been filled by the elevation of Bruce H. Lytle and D. O. Tylee, the former becoming manager of the substation section and the latter manager of the turbine section.

Japanese Railway Buys American Electrical Equipment

The Westinghouse Electric & Manufacturing Company has received an order for motor car and sub-station equipment from the Chichibu Railway which operates in the vicinity of Tokio, Japan. A large part of this new equipment will be a duplicate of the large order shipped from the Westinghouse Company's plant at East Pittsburgh to the Chichibu Railway during the past year.

Personals

Otto R. Hildebrant has recently joined the railway sales department of the U. S. Light & Heat Corporation and will represent the company in the southeastern territory. Mr. Hildebrant's railway experience started in 1905 with the Pennsylvania Railroad at Jersey City. Later going to Philadelphia, he remained with the Pennsylvania until 1909, when he accepted a position with the Safety Car Heating and Lighting Company. Resigning from the Safety Company he joined the Edison Storage Battery Company as chief inspector and sales engineer, which position he resigned in February, 1918, because of dislike for battery work. He then entered the employ of the U. S. Light & Heat Corporation, as representative in the southeastern district, which position he held until November, 1920, when he returned to railroad service on the Florida East Coast Railroad. Recently Mr. Hildebrant was induced to accept his former position with the U. S. Light & Heat Corporation, and is again covering the southeast district for the USL railway sales department. During his long connection with railway car lighting, Mr. Hildebrant has made many friends, and is particularly well known in the South, where most of his experience has been.

Anson W. Burchard, Vice chairman of the Board of Directors of the General Electric Company, has been elected president and chairman of the board of the International General Electric Company succeeding Gerard Swope, its former president, who was recently chosen president of the G-E Company, and Charles Neave, former chairman of the I. G. E. Company, who has resigned.

Mr. Burchard brings to the presidency of the International G-E Company a wide experience in foreign affairs cultivated by personal familiarity with international engineering, commercial and financial problems. He has contributed largely to the development of the manufacturing facilities, financial resources and sales methods of foreign manufacturing and sales agencies in such a

way as to greatly stimulate the expansion of the electrical industry abroad.

Mr. Burchard was born in Hoosick Falls, N. Y., April 21, 1865. After graduating from the Stevens Institute of Technology in 1885 with the degree of mechanical engineer he was engaged in general engineering work with the J. M. Ives Company of Danbury, Conn., and later became treasurer and manager of the T. & B. Tool Company of that city. At the beginning of 1900 and for the next two years his chief interest was temporarily diverted to the mining of copper and, as vice president of the Cananea Consolidated Copper Company, he operated mines in the province of Sonora, Mexico.

In 1902 he joined the organization of the General Electric Company and for the next two years was comptroller. In 1904 he became assistant to the president, and in 1912 was elected vice president. In 1917 he was elected to the board of directors and this year was elected vice-chairman of the board.

Mr. Burchard is also on the boards of the American Power & Light Company, the American Gas and Electric Company, Worthington Pump and Machinery Corporation, the Western Power Corporation, Central States Electric Company, Republic Railway and Light Company, Adirondack Power & Light Corporation, and the Electrical Utilities Corporation. He is a member of the American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Society of Civil Engineers, and the Iron and Steel Institute of Great Britain.

Obituary

Alfred W. Gibbs, chief mechanical engineer of the Pennsylvania with headquarters at Philadelphia, died suddenly from heart failure on May 19 at his home in Wayne, Pa. Mr. Gibbs was born at Fort Filmore, N. M., on October 27, 1856. He attended Rutgers College Grammar School, New Brunswick, N. J., and Rutgers College (the latter institution in 1873 and 1874) and then entered Stevens Institute of Technology, Hoboken, N. J., from which institution he was graduated in 1878. In March of the following year Mr. Gibbs entered the service of the Pennsylvania as a special apprentice in the Altoona shops and continued as such until June 1, 1881, when he became a draughtsman. Four months later he left the Pennsylvania to become a draughtsman for the Richmond & Danville (now the Southern). In 1886 he was promoted to master mechanic and served in that position on several divisions until 1890, when he was appointed superintendent of motive power of the Central of Georgia. Two years later that position was abolished and he returned to the Richmond & Danville as master mechanic. In July, 1893, Mr. Gibbs returned to the Pennsylvania as assistant mechanical engineer and served in that position until September, 1902, when he was appointed superintendent of motive power of the Philadelphia, Wilmington & Baltimore (a subsidiary of the Pennsylvania). On January 1, 1903, he was promoted to general superintendent of motive power of the Pennsylvania Railroad and on July 1, 1911, was appointed to the newly created position of chief mechanical engineer, in which capacity he was serving at the time of his death. Mr. Gibbs was one of the managers of the Franklin Institute, Philadelphia. He served for many years as chairman of the Committee on Tank Cars of the Mechanical Division of the American Railway Association. He was a member of the advisory committee of the Locomotive Cyclopedia for each edition of that volume excepting that of 1912 and at the time of his death was chairman of this committee. Mr. Gibbs played a prominent part in the mechanical design of the electric locomotives built for the Pennsylvania Railroad's electrification at New York.

A. W. Gibbs

Trade Publications

The Uehling Instrument Company, Paterson, N. J. is distributing an illustrated pamphlet known as Bulletin 112 in which the operation of CO_2 recording apparatus is described. The pamphlet is intended as a guide for engineers and firemen in reducing the waste of fuel up the chimney.

The Cutter Company, Philadelphia, Pa., is distributing a 6 by 9 inch 16-page illustrated booklet describing I-T-E Circuit breakers as applied to the protection of electrical and associated machinery in central stations. Both direct and alternating current breakers for various requirements are illustrated and described.

General Electric Co., Schenectady, N. Y., has recently issued its bulletin No. 47326 illustrating and describing type QC-3 quick break lever switches up to 600 volts and 1,000 amperes. The bulletin is an 8-page pamphlet and in addition to the photographic illustrations of the equipment, it also gives a complete set of dimensional drawings.

Over the Mountains by Electric Power is the title of an illustrated folder recently issued by the passenger department of the Chicago, Milwaukee & St. Paul Railway. The folder resembles a time table in general appearance and is profusely illustrated with photographs of various parts of the electrified sections as well as views of the electric locomotives, power houses and substations. Many interesting facts and figures concerning this electrified trunk line road are included in the description.

National Metal Molding Company, Pittsburgh, Pa., is distributing a new catalog describing Liberty rubber covered wires, cables and cords. The booklet contains 20 pages and is 6 in. by 9 in. in size. Specifications to which wires and cables are made are presented, and a table is also included which gives in condensed form all of the data which users of such material need from time to time, including information as to packing and shipping. A description of the manufacture of flexible cords and a comparison of them is particularly interesting.

Railway Electrical Engineer

Volume 13 AUGUST, 1922 No. 8

Direct Drive for Axle Generators

The recent convention of electrical engineers in Atlantic City plainly indicated that the subject of direct drive for axle generators was one to which considerable thought has been given. There is manifestly a very real desire to escape from the belt and its accompanying train of troubles and expenses and it would seem that with sufficient talent brought to bear on this problem some solution which will be generally satisfactory should eventually be forthcoming. There are many who maintain that belts are much more satisfactory than any type of direct drive that has thus far been developed and it is becoming increasingly evident that the belt drive will not be replaced over-night. With the possible exception of a few northern roads where light is desired regardless of expense, the substitute for the belt must prove its merits before it can expect to replace the present generally accepted practice. This does not mean that devices other than belt drive cannot succeed, but until such devices can compete with belts on a cost and maintenance basis, it will be slow and tedious work for them to acquire any standing. In fact, unless the direct drive devices are so constructed that their initial cost and maintenance cost throughout their life can be made to compare favorably with belt operation for the same length of time, the hope of success for the direct drive is not very great.

On the other hand, there is reason to believe that direct drive devices may be eventually brought to a point where they can successfully compete with belt operation. Tests which have been conducted so far are too few in number to prove conclusively the success or failure of any device and many more equipments will have to be installed to determine what may be reasonably expected. The adoption of the direct drive will be gradual—slowly reaching a point where it will equal the belt drive in numbers, and eventually becoming general practice.

This state of transition bids fair to extend over a long period of years, however, so that those who are well stocked with belting need not be alarmed that their supply will exceed the demand.

Electric Heating Devices

With the steadily increasing use of electrical appliances in railroad service, electrical heating devices are making a place for themselves. Among electrical engineers, it is well known that electric heat cannot be used economically for general heating purposes, such as the heating of buildings, but it is also true that for certain applications, fuel fired furnaces are not economical and in a number of cases it can be shown that the heating may be done electrically at a lesser cost. In addition, the amount of spoilage of material can often be reduced, the speed of the work increased, the quality of the finished product improved and better working conditions established. In this manner that which at first glance appears to be expensive proves to be an actual saving.

The term "electric heating devices" is apt to suggest to the casual reader such things as toasters, flat irons, grills and percolators, but in industry it now applies to such apparatus as paint and varnish drying ovens, glue pots, soldering iron furnaces, sherardizing drums, core baking ovens for foundry work, ovens or furnaces for shrinking pits; ovens for drying and baking armature and field coils; melting pots for lead, tin and babbitt; air heaters for cabs; vats for impregnating woods; furnaces for annealing brass, steel and malleable parts; furnaces for heat treating steel forgings, for case hardening, for tempering tools, etc. Rivet heaters and electric welders may also properly be classified as electric heating devices. A paper which was read by E. F. Collins of the General Electric Company before the semi-annual meeting of the Railway Electrical Engineers and which is published elsewhere in this issue describes the apparatus listed above, tells how it is used and shows comparative costs of operation of fuel fired and electric furnaces.

"Electric heating of houses would be a gross waste rather than a conservation of fuel resources and so prohibitive in cost to users as to be beyond all consideration." This statement made in a report on the subject by an electrical engineer is generally conceded to be correct and may be used properly as a guide, but it does not mean that such devices as listed above cannot be used to effect large economies. The field for electrical heating devices on the railroads is a relatively new one; many new and little tried devices are now available and the subject is one which may profitably be investigated by those who have charge of this class of work.

Purchased and Generated Power

The question of purchased vs. generated electric power is brought up for consideration almost every time a railroad contemplates the addition of some new facility. The reason for this is that every modern shop, enginehouse, coal dock, freight house, yard or station requires electric power in some form or another and the total amount of power required in each case is constantly increasing. Many outlying pumping stations have recently been added to the list. The matter of selecting purchased or generated power in

each case, of course, depends largely on local conditions, but the tendency is toward the purchase of more power than formerly. The electrical engineer of a southern road recently said, "The demand for electrical power in our shop has far exceeded the capacity of our boilers and generators, but as long as we can buy power from the public utilities company at the present rate, we cannot justify an expenditure for further additions to our generating plant, for investments in other improvements will pay a much higher return."

The reason for this condition is not that the railroad plants are operated inefficiently, but rather that they cannot successfully compete with many of the public utility plants with their greater size and better load factor. As many of the railroad power loads do not come on at the time of the peak load on a public utility plant, it is possible for the roads in many cases to get highly attractive power rates from the power companies. Exhaust steam can, of course, be used economically for the heating of buildings, but there is a limit to the amount that can be used. Furthermore, the heating of buildings is necessary only in cold weather and in some cases a saving can be made by purchasing power only during certain months of the year. It has been shown that it is advisable to use purchased power in some cases where the connected loads amounted to four and five thousand kilowatts. Where the power requirement is smaller, there is usually more reason for buying power. In view of the changing conditions, it is probable that there are now railroad power plants which are operating at a loss. Have you checked up recently to see what is going on in some of the smaller plants in which you are interested?

Electrification Factors

Just at present the progress of electrification is naturally at a standstill because of the labor troubles which are diverting all thoughts from the subject of major improvements to the more urgent issue of immediate operating problems. It may be, however, as good a time as any to take a retrospective glance over one or two of the more important factors of this most interesting subject.

Probably the one point over which the greatest diversity of opinion occurs is the determination of the system to be used. Both alternating current and direct current operations are strongly supported. Examples of each system in operation can be pointed to with pride by its advocates and when one has heard all of the arguments for and against, one is just as much in a quandary as to which system to select as before. The fact is both systems are giving satisfaction and it is almost impossible for the man on the fence to go wrong, no matter on which side he gets down. The real decision is the one which is made when electric operation is definitely planned.

Nothing but time and trial will prove whether the alternating current system is superior to the direct, or vice versa. At present, it is a fifty-fifty break and until the evidence becomes overwhelmingly in favor of one or the other of the systems, opinions will probably be pretty evenly divided.

In the adoption of electrification, one fact should be kept in mind and that is that the years bring changes in design. It is quite probable that the equipment of today will be more or less obsolete in 10 or 15 years. It will, no doubt, be quite capable of rendering good service but as new equipment is needed, it is altogether likely it will differ in many respects from that which preceded it. There is one factor, however, which has gradually grown to be accepted in the United States, at least, and which is almost certain to be eventually adopted as universal practice and that is the use of the overhead trolley as a source of power supply. There are many advantages in the overhead trolley, not the least of which is that it can be operated at a much higher voltage than is practical for a third rail. It is highly probable that when trunk line electrifications become more general, trolley construction will become standardized in much the same way as a standard gage track is in this country. It would be quite possible at the present time to design the overhead trolley so that it could be equally satisfactory for either alternating or direct current. This feature should be kept in mind in subsequent installations. Of course, the voltages of the two systems are usually quite different and hence would necessitate different insulators, but even this should not present any unsurmountable difficulty. If proper consideration were given to the problem it would seem that the design for an overhead installation could be so arranged that high or low voltage insulators could be made interchangeable.

Electrification of steam railroads must go forward as rapidly as economic conditions justify the expenditure. The pioneer work has all been done and has proved to be wonderfully successful. The element of uncertainty has been entirely eliminated until the only decision to be made is the system to use. Both the a.c. and the d.c. systems are good and it is safe to say that wherever a decision favors one or the other, the real reason lies outside of the inherent operating characteristics of the system selected.

New Books

The Lead Storage Battery.—By H. G. Brown, first edition, 162 pages, 60 illustrations, 6 in. by 9 in., bound in cloth. Published by the Locomotive Publishing Company, 3 Amen Corner, E. C. 4, London, England.

As the name implies, the book deals almost exclusively with the storage battery and deals only briefly with the apparatus for charging them. There are ten chapters with headings as follows: The chemistry of the lead cell; Electrical characteristics; The formation and structure of plates; Stationary batteries; Auxiliary apparatus; Storage battery working; Care, treatment and repair of cells; Battery testing; Battery economics; Portable cells. There is also an appendix which includes a dissertation on the Ionic theory, instructions for testing water and acid for electrical storage batteries and a list of materials required for tests. A color chart shows how to determine whether a given lot of acid can be used over again or whether it should be discarded.

Principles of Alternating Currents. By Ralph R. Lawrence. 432 pp., 6 in. by 8 in., illustrated. Bound in cloth. Published by the McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York, N. Y.

This is a text-book which has been developed from notes on alternating currents used for several years at the Massachusetts Institute of Technology with the junior students in electrical engineering.

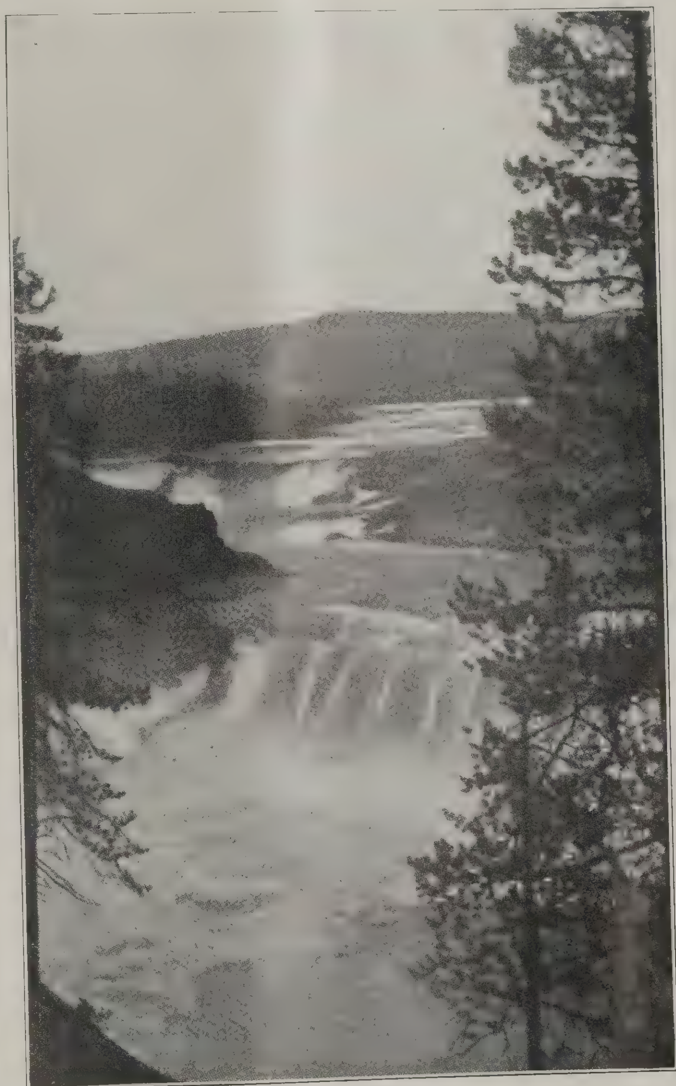
Swedish State Railways Extend Electrification

High Cost of Coal and Abundance of Water Power Combine to Make Electric Operation an Economic Necessity

FUEL conditions have been primarily responsible for the promotion of heavy electric traction in Sweden. In 1915 a commission was appointed to study the situation in detail, and four years later this commission presented a report to the effect that the entire State Railway system could be electrified at a cost of $51,456,000.

Prior to the appointment of the commission, the State Railways had already completed the electrification of an 80-mile section from Kiruna to Riksgransen in the extreme north, where the operating results were beyond expectation.

The cost of coal in 1917 was $20 a ton, and in 1918, $46.90 per ton. These excessive prices naturally led to the use of wood for firing locomotives, which greatly reduced the efficient operation, particularly as it lowered train speeds. Moreover, the country's supply of wood was being consumed much faster than it was grown. Under such conditions, together with the fact that Sweden abounds in water power, the only solution of the railway problem was electrification. With the single exception of Norway, Sweden has a greater supply of water power than any other European country. It has been estimated that the power available from this source is at least 5,000,000 hp., the greater part of which has not been developed.



Lower Porjus Falls

The electrification of the section between Kiruna and Riksgransen was completed in 1914. It is the most northerly part of the Swedish State Railways and entirely within the Arctic Circle. The line is single track, 4-ft. 8½-in. gauge, and the principal traffic is iron ore.

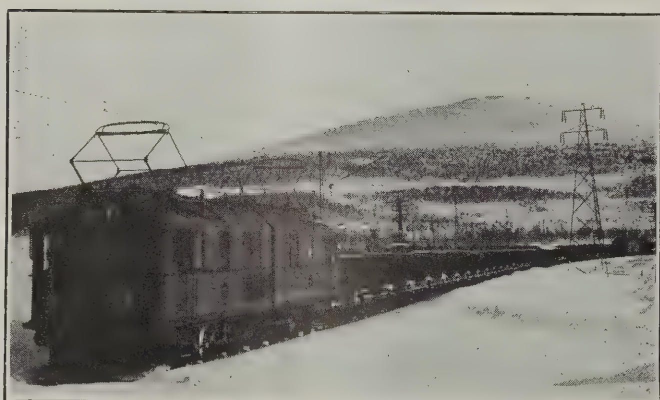
Power is supplied from the power development at Porjus on the Lule river, five miles south of Lake St. Lule. The power line parallels the railroad from Kiruna northward, serving four sub-stations along the line. The equipment in the power house consists primarily of four water turbines and five generators. Two of the turbines are direct connected to 4,000-volt, 15-cycle, single-phase alternating current generators, which develop the railroad power. A third turbine is direct connected to a direct current exciter, and the fourth is direct connected to two generators—a three-phase for lighting a local service, and a single phase for reserve railroad power.

The 4,000-volt power is stepped up through transformers to 80,000 volts, and transmitted over a steel tower transmission line to the substations at Kiruna, Tornetrask, Abisko and Vassijaure, where it is stepped down to 16,000 volts, the voltage used on the overhead contact wire. There are two single-phase circuits on the steel towers of the transmission line. At no place is the transmission line but a short distance from the railroad. The towers are from 60 to 73 ft. in height and are about 660 ft. apart. The slack in the transmission wire is from 26½ ft. to 33 ft., so that the wires in no place are less than 23 ft. above the ground. There are three kinds of towers; one for straight and slightly curved stretches, one for sharp curves and the third for dead end towers. The dead end towers are placed at intervals of about 1¼ miles and are of sufficient strength to hold the strain of all four wires in case the wires break on one side of the tower. They are four-cornered and are constructed of 90-degree angle iron, whereas the other type of towers are three-cornered and are constructed of 60-degree angle iron. The substations at Tornetrask, Abisco and Vassijaure are each part of the railway station at these points. In each substation there are three transformers, lightning arresters and necessary switching arrangement. There is a repair shop in the substation at Kiruna.

The catenary is supported on structural steel poles placed 175 feet apart on tangent track. These poles are

always placed on the outside on curves to permit clear vision for the locomotive runner. The contact wire is hard drawn copper of figure 8 section of 80 sq. mm. area. The catenary is a 7-strand copper cable of 50 sq. mm. section. The contact wire is supported at each pole and to the catenary at two points between each pole. The sag in the catenary between poles is 4 ft. 3 in., and the sag of the contact wire between supports is about 3 in. The contact wire is divided into sections about seven-eighths of a mile long. Over open track the contact wire is 18 ft. 6 in. above the rail; in tunnels and snow sheds this is reduced to a minimum of 15 ft. At stations and yards the catenary is supported by overhead bridges.

When this line was first put in commission in 1914, 15 locomotives were provided, two passenger and 13 freight. The passenger locomotives are of the 4-4-4 type, weigh 82 tons and are capable of a speed of over 60 miles an hour. The freight locomotives are of the 2-6-6-2 articulated type, weigh 140 tons, have a tractive effort of 33,000 miles and are capable of a speed of 43 miles an hour.



An Ore Train on the Riksgransen Railway

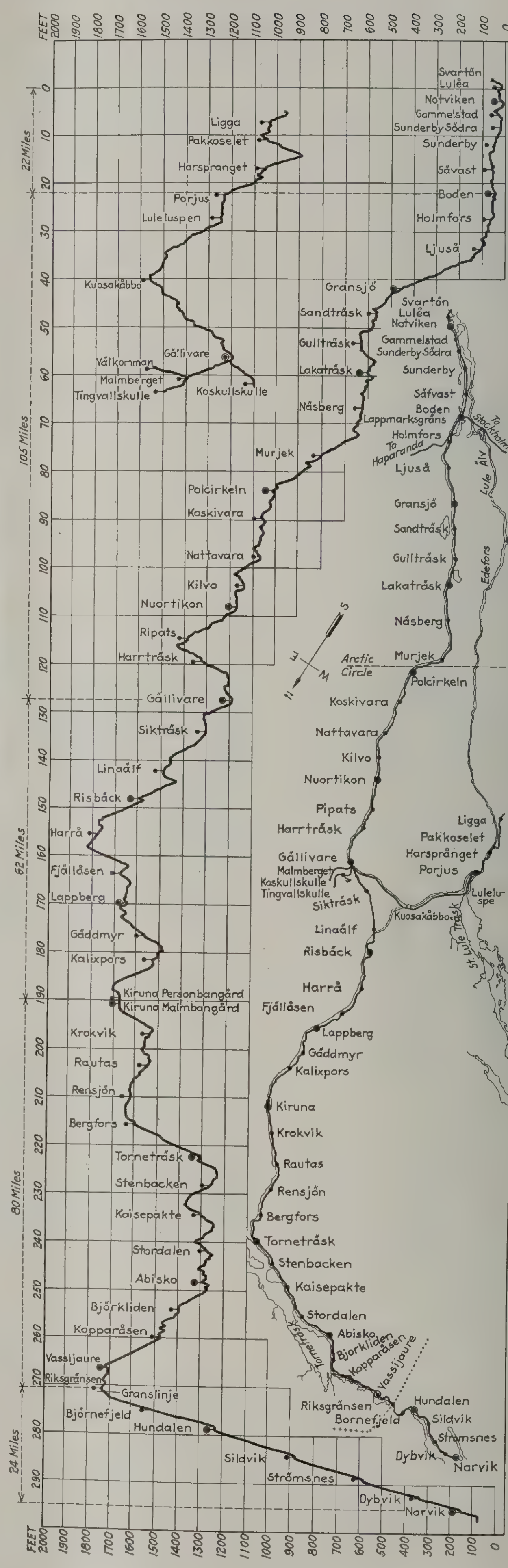
The principal dimensions of these locomotives are as follows:

	Passenger	Freight
Diameter of driving wheels	62 in.	43½ in.
Diameter of guiding truck wheels	38 in.	28¾ in.
Rigid wheel base	9 ft. 6½ in.	14 ft. 1½ in.
Total wheel base	33 ft. 2 in.	47 ft. 11 in.
Length over all	40 ft. 1 in.	61 ft. 1 in.
Number of driving motors	1	2
Horsepower per motor	1,000	850
Revolutions per minute	170	150
Tractive effort	12,000 lb.	33,000 lb.
Weight per driving axle	33,000 lb.	38,600 lb.
Weight per truck axle	28,700 lb.	38,600 lb.
Total weight	180,800 lb.	308,800 lb.
Weight on drivers	66,000 lb.	231,600 lb.

Additions to Electrified Sections

The first addition to the original electrified line extended from Kiruna southward to Nattavara, a distance of about 90 miles. This work was completed in October, 1921. A little more than two months later the electrified section had been extended to Boden, about 74 miles further south, and the remaining distance to Lulea will be under electric operation by July of this year.

A part of the line which extends across the northern part of Norway from Riksgransen to Narvik, is known as the Ofot Railway. This line is also being electrified and it is expected that the work will be completed by the first of October, 1922. The greater part of the entire line lies north of the Arctic Circle.



Profile and Route of the Electrified Portion of the Swedish State Railways

The Use of Electric Heat in the Railroad Shop*

There Are Many Improved Facilities Available Which Are Also Economical

By E. F. Collins
Industrial Heating Department, General Electric Company, Schenectady, N. Y.

MANY engineers unfamiliar with the possible economies of industrial electric heating have been in the past restrained from an analytical study and investigation of its application and inherent merits and have dismissed it from serious consideration on the false theory that it is an expensive and impractical method of heating. They have reasoned superficially that the heat of

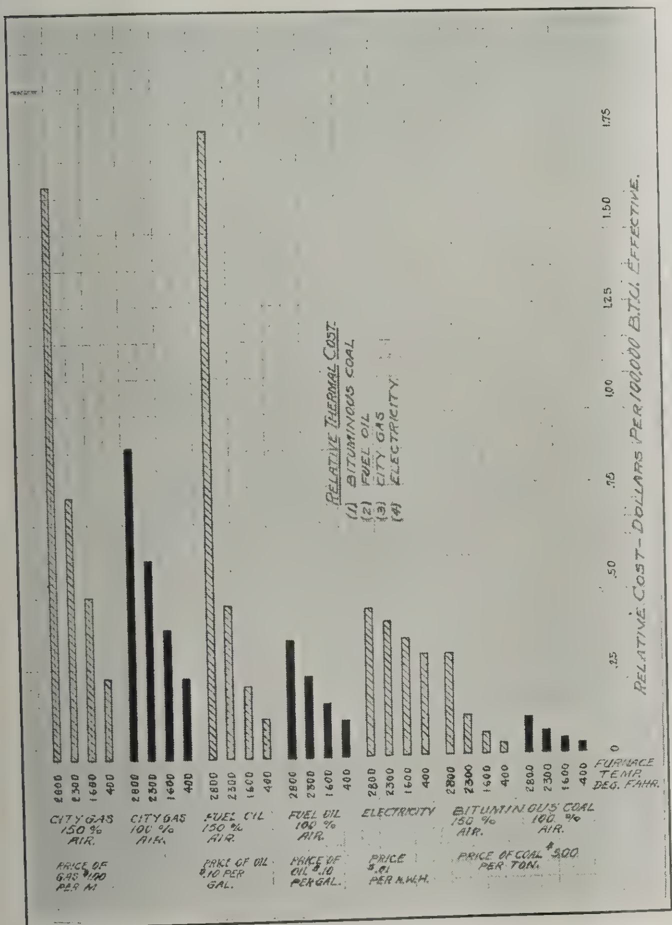
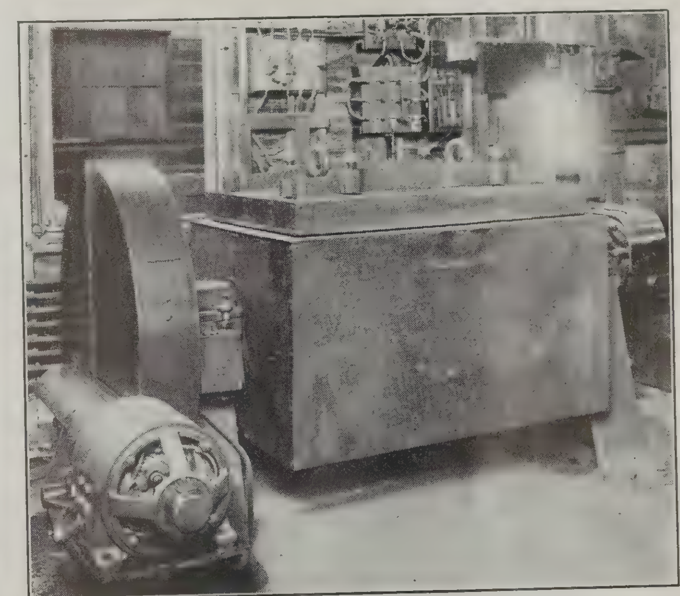


Chart Showing Relative Costs of Operation of Various Types and Sizes of Furnaces Under Proper and Improper Conditions

the fuel is liberated directly in the fuel fired furnace when it is burned, whereas the electric furnace requires a supply of electric energy which is the product of a secondary process thrice removed from the primary heat of combustion, i. e., the heat of combustion in the furnace produces steam in the boiler, which in turn is converted into power by the engine which drives the dynamo to generate the electricity which is finally converted into heat in the electric furnace.

Further serious consideration would have convinced them that the inherent advantages of electric heating, due in some cases to its form factors, in others to its perfect heat control and distribution, were such that the B. T. U. utilized and developed electrically may actually cost less than that utilized from fuel burning devices; and in many thermal processes their advantages more than over-balance the apparently more expensive and indirect utilization of the heat units in the fuel. For after all, the conversion of heat units of the fuel to electricity is in the main a simple and efficient one.

If one remembers that the efficiency of conversion of electricity to heat in the electric furnace is 100 per cent



A 50-Kw., 24-In. by 24-In. Sherardizing Drum

he may at once drop this from consideration, for against this 100 per cent efficiency of conversion we have much lower efficiencies for three common fuels, viz., coal, gas and fuel oil. Due first to the difficulty of maintaining perfect combustion, and second due to the passing of products of combustion from the furnace, there is a double loss of heat in the fuel fired furnaces not met in the electric, where perfect conversion of heat obtains, and no combustion gases are generated to continuously flow from the furnace carrying with them, unused, a greater or less percentage of the total heat which in turn has been more or less incompletely generated due to imperfect combustion. An excess of 50 per cent air is a condition by no means rare in the practical operation of fuel fired furnaces. As a matter of fact it is nearer the rule than the exception.

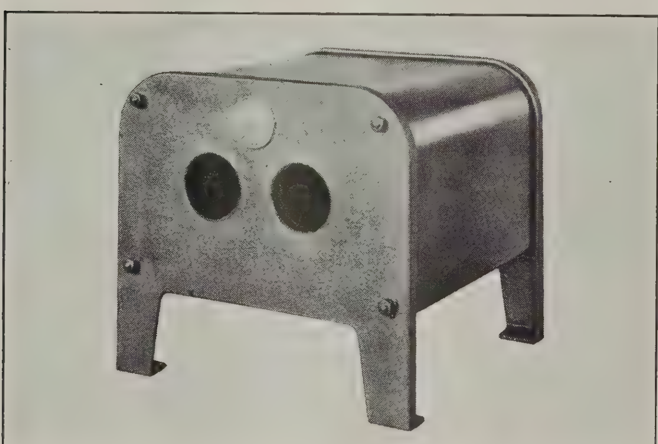
Hence from the above it is readily seen that the ratio of the cost of B. T. U. in the fuel and the B. T. U. generated electrically cannot in itself determine whether over-all cost

*An abstract of a paper presented at the semi-annual convention of the Association of Railway Electrical Engineers at Atlantic City, N. J., June 19, 1922.

or final economy will in any particular process be secured by the electric or by the fuel fired furnace or heater; for if this were so, how could we justify the use of gas or fuel oil as against coal in any case? Yet economies result from the use of gas and oil instead of coal, and likewise electricity is daily demonstrating that in many places and processes it can show economies in over-all costs of production that are at times startling as compared with the costs resulting from the use of fuels directly. The writer has in mind operations where costs per piece have been reduced 25 per cent through the use of electric heating. Cases have been met where a rate of 75 cents per kw. hr. would not make the use of electric heat less economical than that from fuel direct. These are of course exceptional cases but are given to emphasize the value of the advantages inherent in the use of electric heat for many purposes. It is not intended here to propose the use of electric heat in all cases, as against fuel heat, because many cases exist where electric heat is in no wise a competitor of fuel fire equipment, and in such cases the author would protest against the use of electric heat.

From the above, and for many other reasons which the writer might outline, it follows that the use of the proper source of heat for industrial processes should receive a most careful consideration from all angles and in all phases before deciding upon that type best suited to the process under consideration. The best procedure is to secure the advice of competent heating engineers.

Heat energy application in this country has in the past been largely a composite result of promotion and advertisement rather than of thermal engineering. We have had fuel oil advocates, gas burning experts, powdered coal enthusiasts, and perhaps electric heating experts, etc., but

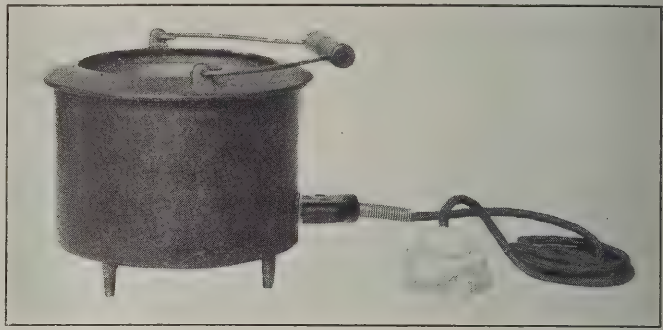


An Electric Soldering Iron Furnace

have until recently lacked the competent furnace engineer familiar with all types of furnaces, and who could sit as court of appeal and give unbiased decisions regarding true economic value of various heat sources for a specific purpose. To operate a certain process with gas that might be more advantageously carried out with other forms of heat energy is not economy, yet many such cases exist today. There are many gas devices operating today that should long since have been scrapped for electrical.

Applications of Electric Heat

Some of the applications of electric heat which are giving results in many places will be tabulated here. This list is presented with the hope that a careful analysis of possible economies which may be effected through its use will be made by individual engineers in their own particular shop and under their own particular requirements, local conditions and environment. The writer feels sure that electric heating will only thus get its full share of the work to do, and he repeats that this "full share" is only that which may be justified by true "intrinsic value" of the electric heating method over that of fuel heated equipment. Standard types of heating equipment which have already been widely used afford the engineer today



A Compound Melting Pot With a Capacity of 4 Quarts

opportunity to utilize electric heating in the following list of general industrial processes:—

1. Heaters for drying paints, varnishes, laquers—interior and exterior.
2. Glue pots for cabinet work and similar requirements.
3. Soldering iron furnaces.
4. Sherardizing drums for mat or polished non-corrosive coating.
5. Core baking ovens for brass or iron foundry work.
6. Ovens or furnaces for assembly or shrinking fits.
7. Ovens for drying and baking armatures and field coils.
8. Pots for melting lead, tin and babbitt.
9. Vats for impregnating woods, such as ties.
10. Air heaters for crane cabs.
11. Furnaces for melting metal for bearing linings (brass).
12. Furnaces for annealing brass, steel or malleable iron parts.
13. Furnaces for heat treating steel forgings.
14. Furnaces for case hardening steel parts.
15. Furnaces for hardening and tempering steel tools, dies, etc.
16. Rivet heaters for heating steel rivets.
17. Arc welding apparatus for repairs and track welding.

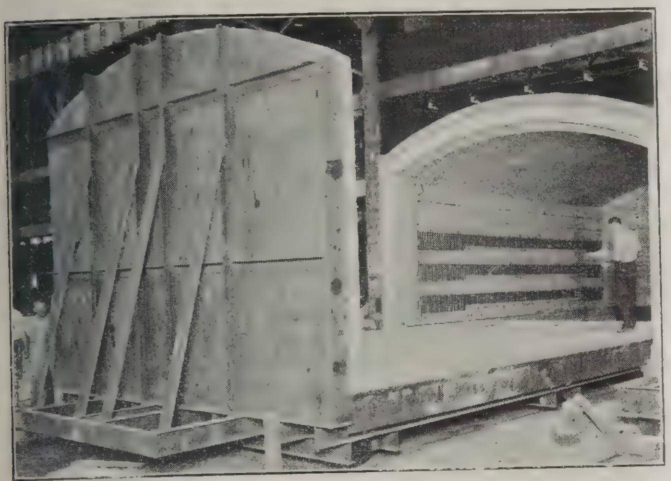
It is desired to show some concrete illustrations of the application of electric heat which have already demonstrated their worth in several processes above listed.

The baking of japan electrically has become a standard process where production and high standards of finish and durability of cost is a requirement. Ovens from the smallest size to those turning out by conveyor means 60 automobile bodies per hour and carrying 3,000 kw. in heaters have been in commercial use for several years past, and have given universal satisfaction to the users.

Pots suitable for glue melting or compounds such as are used in the storage battery work are made having

capacities of one to eight quarts and use from seventy to eleven hundred watts. Many hundreds of these pots are in constant use today.

Electrically heated soldering iron furnaces for moderate and heavy duty irons lower production costs, reduce fire hazards, eliminate excessive heat and the noxious fumes of combustion furnaces. These have capacities of 1,500



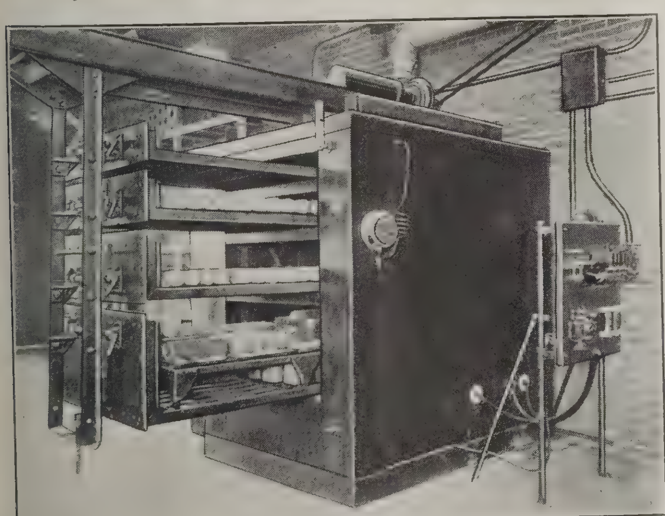
An Electric Heat Treating Furnace, 15 Ft. 10 In. Wide, 27 Ft. 7 In. Long, and 8 Ft. 7 In. High, With a Maximum Temperature of 1000 Deg. F. and a Connected Load of 620 Kw. Heat Control is Automatic

and 2,000 watts for 110- and 220-volt circuits with double heating muffle.

Sherardizing

Sherardizing, dry galvanizing or zinc coating is best carried out by the aid of electric heat.

Bright polish, equivalent in appearance and superior in rust protecting and non-corrosive qualities to a nickel coat or plate, may be secured by this process. The protection of metal parts from corrosion and rust such as cast iron, malleable iron and steel is complete and uniform in contrast to the hot galvanized product. Screw threads and fits may be completely protected and yet maintain standard



A Four-Drawer Core Baking Oven With Automatic Heat Control and With a Connected Load of 36 Kw. and a Maximum Operating Temperature of 375 Deg. F.

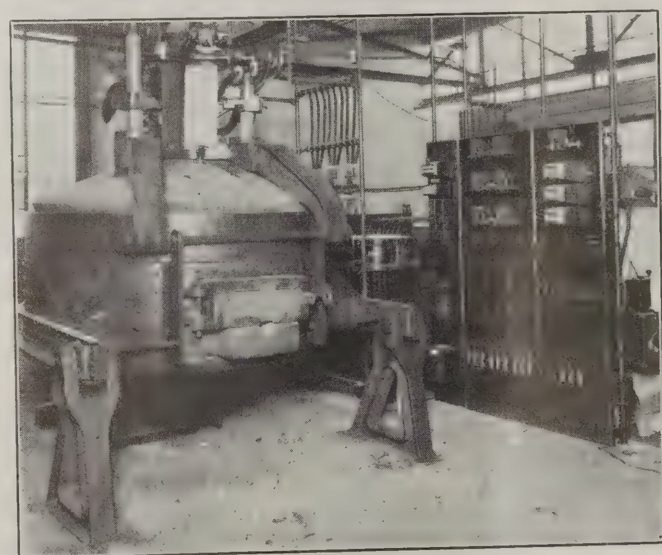
dimensions. The sherardized coat endures weathering double the length of time for the same weight of zinc deposited per square inch of surface by hot galvanizing. A sherardizing drum, 24 in. by 24 in. by 40 in., will carry a ton or less of material per charge and requires about 50 kilowatts in heating capacity.

Core Baking Ovens

Core baking ovens are made in sizes using 36 kilowatts and larger. A battery of four 86-kw. ovens in a foundry showed efficiencies of 10.9 to 14.5 pounds of green cores baked per kilowatt hour. A total weight of 108,730 lb. required 9,390 kw. hr. to bake and heat the ovens for one week. This is 11.5 lb. of cores per kw. hr. Considering the cost of power alone, the electric power costs about 45 per cent more than the gas heating costs in this foundry. On the other hand, perfectly baked cores are always obtained from the electric ovens and the production per oven has increased 35 per cent. In over a year's production this foundry reports not a single charge of burned or cracked cores from the electric furnace.

Shrinking Furnaces and Japanning Ovens

Shrinking furnaces were used during the war in connection with gun making. These range from an 8-kw.



A 1500 Lb. Non-Ferrous Melting Furnace With a Capacity of 250 Kw.

furnace, 27 in. in diameter and 25 in. deep, to those accommodating large gun tubes 88 ft. long. Such furnaces were arranged for temperatures of 750 to 1,000 deg. F. and had heating capacity of 1,100 kw. Gun jackets about 85 ft. long were heated from end to end with a temperature variation throughout their length of not more than plus or minus 5 deg. F., giving perfect shrinking fit throughout between tube and jacket. For shrinking wheel tires and such work the electric furnace should be valuable to the railroad shop and at the same time economical.

Ovens of the general type for japanning are well suited for drying or baking armatures, commutators or field coils. High insulation resistance and dielectric strength results from this type of heat.

Babbitt Pots and Heat Treating Furnaces

Lead, babbitt or tin melting may be done safely in electrically heated pots. No overheated babbitt need ever enter a bearing shell with automatically controlled melting pots.

Rotary hearth type electric furnaces are suited to annealing, hardening and heat treating metal parts. The maximum temperature used is 1,800 deg. F.

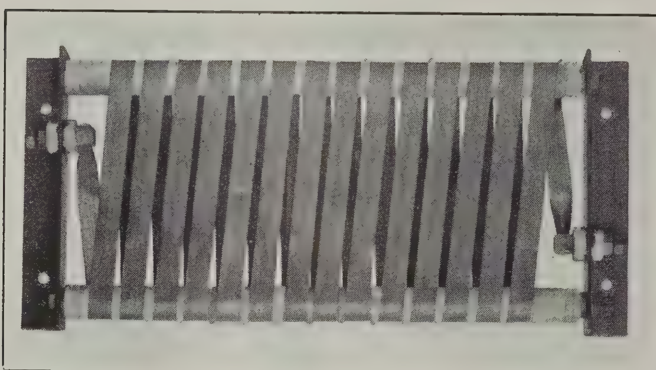
Rivet Heaters

Rivet heaters for steel rivets are made which give a uniformly heated rivet free from burning or mushing. In continuous operation from three to five pounds of steel rivets can be heated per kw. hr., depending on the size of the rivet. The rivet is heated as it should be, from the inside rather than from the outside, and without burning or scale. This contributes to a better riveted joint. Many of these heaters are in successful operation.

Melting Furnaces

The contact arc resistance furnace has been developed giving a high melting rate and efficiency and requiring small floor space. The type of furnace is controlled automatically. The vertical electrodes form contact resistance arc in a pot of granular graphite.

A furnace with a hearth capacity of 2,000 lb. of brass and with 250 kw. connected will melt yellow brass in pig or heavy scrap form at the rate of 1,500 lb. an hour and with a metal loss of less than 1.5 per cent and a power consumption not in excess of 270 kw. hr. per ton. Copper



A 110-Volt, 3.8-Kw. Air Heater for Wall Mounting

is melted at the rate of 1,300 lb. an hour with a power consumption of 350 kw. hr. per ton. This power consumption is based on melting not less than 1,500 lb. charges and allowing 20 minutes per heat for charging, pouring and foundry delays. The furnace is equipped with an indicating pyrometer and is suitable for melting nickel and monel metal. A power factor of 95 per cent and better is realized together with freedom from load fluctuations.

Electric Welders

The production of the automatic welder marks the latest development in the art of metallic welding, refinement of automatic precision, economy of labor, material, time and current.

The extraordinary speed and efficiency which characterize the operation of this equipment adapt it especially to quantity production, continuously repeated work, building-up processes and many forms of seam welding.

It should be an important and valuable addition to any railroad equipment shop wherever continuous union or building up of iron and steel are essential. The equipment welds with a minimum of human guidance. It consists of a mechanical device for automatically feeding a bare metallic electrode wire to a welding arc at the rate required to hold a constant arc length, this being automatically controlled through a control panel which acts as the brains for the feed meter of the mechanical drive for this equipment.

In conclusion, it is hoped that this brief and incomplete outline of some of the possibilities of electric heating in the railway shop may induce electrical engineers seriously to investigate and consider the inherent economic advantages of electric heat along with those afforded by fuel heated apparatus, at least whenever new or improved equipment is added to their shops, and we believe that their experience so gained will ultimately, if not immediately, result in the replacing of certain fuel fired equipment with electric heated devices.

We feel confident that a full knowledge of what may be accomplished by electric heating will materially aid the engineer in equipping his shops to give further increased economy of operation which he desires and which the immediate future will demand.

Discussion of Paper on Electric Heating at the A. R. E. E. Convention

We have a very important paper now to be read to us by Mr. E. F. Collins, of the General Electric Company, on the subject of Industrial Heating.

This is a subject, as far as the railroads are concerned, that is very little known about, and we have very little reference on it; and this paper should form a very valuable addition to our principal proceedings.

I have great pleasure in calling on Mr. Collins now to give his address on Industrial Heating.

CHAIRMAN MACNAB: Gentlemen, we have listened to a very interesting paper from Mr. Collins.

I might say that in our shops in Montreal, we have installed a considerable number of the devices that Mr. Collins mentioned, such as armature baking ovens, babbitt melting pots, soldering irons, tool hardening ovens, etc., and of course, in the Province of Quebec, we have hydro power, by which we get a very low rate, and they are very economic, and from the operating standpoint they are very satisfactory, as we have had very little trouble from them.

MR. HILL: I would like to ask Mr. Collins a question. The Dunn Electric Company have some equipment which corresponds with Professor Thompson's, with regard to electric device for expanding tires. Do you know how far they have gone with that?

MR. COLLINS: I am associated with the practical end of this business, rather than with the laboratory end. Professor Thompson has charge of the laboratory; but I would say that we have designs for just such purposes.

MR. BOUCHE: Do I understand that these furnaces that you described are all heated with the resistance type heaters?

MR. COLLINS: These furnaces that I have described are all with the metallic resistors, and they are identically the same furnaces which were operated during the period of the war, that is, the last year of the war, for the heat treating of guns and shrinking of guns.

CHAIRMAN MACNAB: Now gentlemen, a motion of thanks to Mr. Collins for his fine paper will be in order.

CHAIRMAN MACNAB: All those in favor will signify by saying "aye." It is carried unanimously.

Note:—This paper is printed on page, 251, of this issue. Editor.

The Advance in Industrial Electric Traction

Superiority of Small Electric Locomotive Over the Steam Operated Unit Is Manifested in Economy of Power

By Gordon Fox

Part I

FOR short distance horizontal transport of materials in the industrial plant, the electrically propelled vehicle is gaining in popularity. Two general classes of equipment apply, namely, trucks and railway vehicles. This article deals primarily with electrically operated railway cars and locomotives, although the problems and practices with other vehicles are in many respects similar.

Advantages of Electric Drive

Electric drive affords many advantages in industrial railway service. The efficiency of the electric locomotive, from a power standpoint, is much superior. A steam locomotive requires three to four times the amount of coal for hauling a given load, as compared with an electric locomotive fed from an efficient power plant. In industrial service the steam locomotive ordinarily consumes considerable coal while standing idle, whereas the standby losses of the electric locomotive and electric system are practically nil. The steam locomotive loses not a little time in taking on fuel and water and frequent boiler cleaning and repairs are necessary. Repairs on electric locomotives are usually of minor degree and delays infrequent. The absence of fire, smoke, steam, gas and noise may be of material advantage, particularly for work within buildings or in mines or enclosures. The electric locomotive does not require a fireman nor is a high degree of skill demanded of the operator. Electric traction affords smoother action, due to the uniform torque developed by the motors and accurate control readily obtained. Closer proximity and better observation of the work are sometimes possible. The low head room required by mine type locomotives is a valuable attribute in that field.

Probably the most extensive use of industrial electric traction is in mining where the electric locomotive is employed for gathering and hauling mine cars. There are many applications about the steel mill. Poling locomotives may spot the coal or ore cars at the car dumper. Transfer and scale cars transport coal or ore for short distances. Quenching cars carry the coke to the tower where it is sprayed with water. Electric locomotives may handle the cars at the coke loading station. In the steel mill electric locomotives may be used for transporting charging cars, ingot cars, etc. The electrically propelled ingot buggy carries the heated ingot to the mill. Slab buggies transport the slabs from furnaces to the mills. There are many specific applications. It is quite possible, moreover, that general switching and spotting service will be more generally accomplished electrically and that the electric locomotive crane will supersede the steam crane for many services. In other industrial plants there are similar applications.

Electric propulsion may be accomplished either through the medium of the electric locomotive or through the use of cars which are themselves equipped with motors. Electric locomotives in turn may be broadly classed as mining types and industrial types, also as battery, collector or combination equipments. The mine type locomotive is designed for most compact construction and for severe service. The industrial locomotive usually permits of greater space and requires less rugged features.

Storage Battery Locomotives

Storage battery locomotives are most common in the smaller sizes, from 3 to 15 tons weight, although equipments up to 30 tons are in service. The battery locomotive is best suited for short, light hauls over a rather extended and fairly level track system. It is self contained and can go wherever there are tracks. It avoids the cost and complication of collector devices. The fact that the battery may be charged on off peak hours may be advantageous. For steady or heavy duty the first cost and battery depreciation cost of a battery locomotive, particularly of large size, are usually prohibitive. For intermittent duty, such as switching and spotting, batteries may be worked at high discharge rates and are feasible as to cost.

The Trolley Locomotive

The locomotive which is fed from a trolley or third rail is simpler, cheaper, more rugged and more efficient. It requires less attention and maintenance. It is always available and it is long lived. Against these advantages must be set the disadvantages of cost and possible complexity of the current distributing and collecting system.

The Combination Type

The combination locomotive is equipped with a battery and also with collectors. The yard in which it operates need be only partially equipped with rails or trolley. The main lines of traffic, the grades or the heavier runs may well be equipped with collectors. Spur tracks or portions of the yard where the service is infrequent or light need not be so equipped. A 250-volt locomotive is provided with some 120 to 140 cells which are arranged to float on the line perhaps in connection with ballast resistance and to charge at least in part while the locomotive is connected to the power system. With a proper adaptation of the battery to the service, this arrangement is quite satisfactory. Some battery locomotives are provided with a battery of 125 volts or thereabouts. This type of battery does not float on the line but is separately charged. The motors may operate two in parallel on the battery and two in series on the trolley. The operation of two motors in series on

a locomotive is open to objection in that slippage of one pair of wheels may cause nearly full line voltage to occur across the one motor, the difficulty being cumulative. The voltage across the other motor, and consequently its torque, are correspondingly reduced.

Collector and combination types of electric locomotives for industrial switching service range, for the most part, in sizes from 20 to 60 tons weight. Mining locomotives range in size up to 30 tons weight, most of the equipments being below 20 tons.

Operating Factors and Conditions

The propulsion of a car or train requires tractive effort, the work done being made up of several components, viz.:

1. Train Resistance.
2. Grade and Curve Resistance.
3. Acceleration.

Train resistance in turn comprises friction and wind resistance. The friction of the car journals depends primarily upon weight. Rolling friction includes the uphill climb due to sag and depression of track and also the friction of the wheel flanges. This increases with the speed, but, within the range of speeds in industrial service the variations due to speed are small. These friction components depend materially upon the type and condition of equipment and track. For standard gauge equipment on good tracks friction draw bar pull may be taken at 10 to 15 lb. per ton of weight. For mining locomotives a figure of 20 lb. per ton is much used. For mine car with loose wheels on fixed axles 30 lb. per ton is common practice. For an ingot buggy, having poor track conditions, values of 30 lb. to 40 lb. per ton are to be expected.

The speeds prevailing in switching service do not themselves create air friction of any note but, for some outdoor applications the effect of the wind itself must be considered. For this purpose Fig. 1 is given, showing the draw bar pull per unit of exposed area, due to wind.

A one per cent grade means an elevation of one foot in 100 ft. of track. Thus the tractive effort necessary to overcome a grade is $\frac{2000}{100} = 20$ lb. per ton weight for each per cent grade. It is evident that grades may largely determine the size of locomotive required. Particularly in mine service where long trailing loads occur the length of the grade is important as determining the number of cars that may be on the grade at one time. In case of down grades the grade resistance is a minus quantity.

A one degree curve is one in which a 100 ft. chord will subtend an arc of 1 degree. The radius of a 1 degree curve is approximately $\frac{100 \times 360}{2\pi} = 5{,}730$ ft. It has been found in practice that the additional friction incident to rounding a curve is about 0.8 lb. per ton for each degree of curvature.

The acceleration of a car or train involves the overcoming of inertia and imparting of kinetic energy to the moving masses. In addition to the linear motion of the car or train the rotation of armature, gearing and wheels is involved. The following may be used: Acceleration at the rate of 1 ft. per sec per sec requires a tractive effort of 68 lb. per ton of weight, plus train, grade and curve resistance. Acceleration at 1 mile per hour per sec requires a tractive effort of 95 lb. per ton weight. Acceleration at other rates requires proportional values of accelerating tractive effort. Where level track only is involved the acceleration load will be relatively more important than where grades are to be met. The rate of acceleration can be reduced on grades if necessary. In mine service acceleration is rather slow and the starting load is not then a factor of first importance.

Having evaluated the various load components let us consider the derivation of the tractive effort necessary to overcome this load. Tractive effort may be defined as the force in pounds developed at the rim of the driving wheels. It is directly proportional to motor torque and to gear ratio. It may be restricted by motor capacity. It is positively limited by slippage of the drivers.

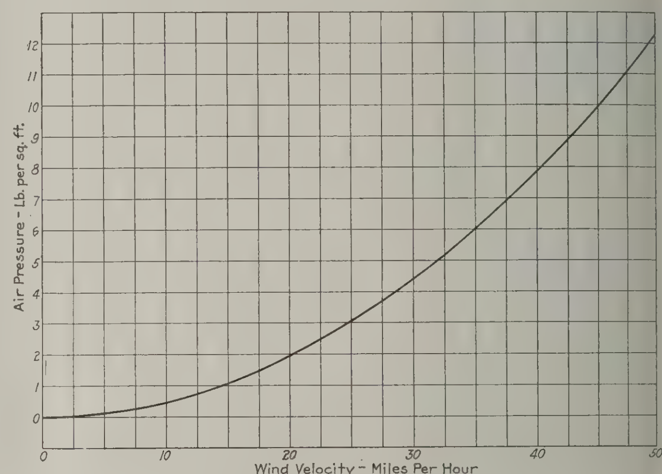


Fig. 1—Draw Bar Pull Due to Wind Pressure

The amount of traction which can be obtained between wheels and track depends upon the weight on the drivers, the material of the wheels and the condition of the track. Steel wheels give higher traction than cast iron wheels. The following values are widely used for calculations:

Cast Iron Wheels	
Dry rails with sand	25% of wt. on drivers
Dry rails without sand	20% of wt. on drivers
Wet rails	5 to 15% of wt. on drivers
Steel Tires or Steel Wheels	
Dry rails with sand	33% of wt. on drivers
Dry rails without sand	25% of wt. on drivers
Wet rails	5 to 15% of wt. on drivers

Steel wheels, well worn in, with sand, may develop an adhesion of 40 to 50 per cent of the weight. Where braking ability is important, as in holding back on a down grade, a conservative value, about 15 per cent, should be used in calculations.

It is evident from the above that the weight of the locomotive or car must be from 4 to 6 times the tractive effort where all the weight is on the drivers. If the weight be less slippage will occur before the desired tractive effort is obtained. It is evident that, due to the better adhesion, steel tired wheel locomotives may be considerably lighter than those equipped with cast iron wheels. The weight of locomotive which can be used on a given system is restricted, of course, by the weight of rails installed.

Grades have a decided influence in reducing the hauling capacity of a traction locomotive, not alone because

of the increased draw bar pull from the trailing load, but also because a material portion of the tractive effort developed is required to carry the locomotive weight up grade, decreasing the net draw bar pull available. Thus a 10-ton locomotive which will haul 100 tons of train weight on level track, will haul but 45 tons up a 2 per cent grade and only 27 tons up a 4 per cent grade. The necessity of weight in a locomotive to afford traction is thus a distinct advantage on grades.

The following formula may be used for determining the locomotive weight necessary for a given set of conditions.

$$L = \frac{W\ (F + 20\ G + .8\ C)}{20\ (A - G)}$$

Where L = required weight of locomotive—tons
W = weight of train—tons
F = train resistance due to friction—pounds per ton of train weight
G = per cent grade (if entire train on grade)
C = degrees curvature (if entire train on curve)
A = coefficient of adhesion of locomotive wheels—per cent

The motor or motors required for a locomotive or car depend upon the torques required in starting and upon the heating resulting from the operating cycle. For the smaller industrial cars a single motor is often employed. This is geared to one axle so that either one-half or one-quarter of the wheels are driven. For larger cars two motors are more commonly geared to two axles so that at least half the wheels are driven. On locomotives all or most of the weight is on the drivers, all of which are driven, developing the maximum tractive effort which the weight of the locomotive will afford.

The motor torque required in starting depends upon the tractive effort demanded in starting. This is made up of train resistance, curve and grade resistance and inertia load. Formulæ have been given for determining these load components. The formula for the inertia component involves the rate of acceleration. Mining and switching locomotives, handling a capacity load, are commonly accelerated at about 0.2 to 0.5 ft. per sec per sec respectively, corresponding to 0.15 to 0.35 miles per hour per sec. Industrial motor cars are accelerated at various rates, usually between 0.5 and 1.0 ft. per sec, per sec, depending upon weight and service.

The tractive effort required to accelerate a car or train being known, the motor torque corresponding depends upon the wheel diameter and the ratio of gearing between axle and motor. If a low gear ratio be used a high running speed will ultimately result but acceleration with given motor equipment, will be slow or, for a given acceleration rate, a large motor capacity will be required. If a high gear ratio be used, relatively rapid acceleration may be obtained or the required torque may be developed by smaller motors. The motor size and gear ratio to be used are determined, at least in part, by free running conditions. The motor power required for free running condition may be determined by the formula

$$HP = \frac{TE \times V}{33000 \times .85}$$

wherein TE is the tractive effort required for train resistance, grades and curves and V is the free running speed in ft. per min. The decimal .85 covers the gearing efficiency. Gathering locomotives in mine service usually run at about 5 miles per hour. Mine haulage locomotives of the trolley type commonly run at about 7 to 10 miles per hour. The speeds of industrial cars must be adapted to the service, usually in the range 5 to 10 miles per hour. Industrial locomotives range in speed up to 25 miles per hour. An industrial switching locomotive should have sufficient speed for "kicking in" or "flying switch" duty. If a switching locomotive or car is to be used for rather long runs with infrequent starts the free running HP may be made about 75 per cent of the 1 hr. rating. If frequent starts are involved and the service is quite continuous the free running HP should be about 50 per cent of the one hour rating of the motors. On this basis the motor size may be at least tentatively determined. The corresponding motor speed may then be read from the motor characteristic curves. Knowing the desired free running velocity of the car the gear ratio may be computed.

The starting torque developed by the motor or motors during the period of approximately uniform acceleration while the starting resistance is being short circuited may be taken as that value corresponding to one and one-half times full load current. From this value the tractive effort developed during acceleration may be computed. The resulting rate of acceleration may then be determined. The tractive effort developed may also be checked against the maximum which will slip the wheels. If a motor torque is excessive smaller motors may suffice or the gear ratio may be changed. In the case of a locomotive it is usually desirable that the motors be able to develop sufficient starting torque to slip the wheels. The pulling power of the locomotive is then limited by its weight only and the motors are protected against excessive peak currents. In the case of an individual car this is not necessary so long as the motors develop safely sufficient torque to give the tractive effort for the desired acceleration.

The Russian railways are in a deplorable condition owing to the lack of supplies. On January 1, 1917, the serviceable mileage was approximately 44,000. On January 1, 1921, it was only about 29,000 miles.

Photo by Ewing Galloway

New York Central Docks at Weehawken, N. J.

New Passenger Locomotive Being Tried Out by North Eastern Railway, England

A NEW type of electric locomotive for high speed passenger service, which has a symmetrical wheel arrangement and unusually large driving wheels, is being tried out on the North Eastern Railway in England. The locomotive was designed by Sir Vincent L. Raven, chief mechanical engineer, North Eastern Railway, the mechanical parts were built by the Locomotive Works at Darlington and the electrical equipment was supplied by the Metropolitan-Vickers Company. Only one locomotive has been built.

The locomotive is designed to haul a 450-ton express passenger train at an average speed of 65 miles an hour on level tangent track. The running gear is designed for a maximum safe speed of 90 miles an hour without doing damage to the mechanical parts of the locomotive, which is of the 4-6-4 type and consists of main frames mounted on three driving axles with three pairs of driving wheels 6 ft. 8 in. in diameter, and a four-wheel truck at each end. The cab and sloping ends are rigidly fixed to the main frames, and are provided with the necessary supporting members for carrying the auxiliary and control equipment.

General Dimensions of North Eastern Passenger Locomotives

Wheel arrangement	4-6-4
Electrical system	Direct Current
Voltage	1,500
Length over all	53 ft. 6 in.
Width over all	8 ft. 10 in.
Height, pantograph locked down	13 ft. 0 ⅛ in.
Driving wheel diameter	80 in.
Pony wheel diameter	43¼ in.
Rigid wheel base	16 ft. 0 in.
Weight of locomotive	102 tons
Weight per driving axle	18 tons 10 cwts.
One hour rating—Tractive effort	15,900 lb.
Speed	43 m.p.h.
Horse power	1,800
Continuous rating—Tractive effort	9,480 lb.
Speed	51.5 m.p.h.
Horse-power	1,300

The current is collected from the overhead trolley by pantographs mounted on the roof at each end of the center compartment. The main traction motors, which are of the twin-armature type, are rigidly fixed to the main frame of the locomotive, and transmit the torque to a gear wheel mounted on a hollow shaft or quill. The connection between the quill and driving wheels is through springs. The high tension apparatus is located in one of the sloping ends; the other sloping end contains an electric boiler for supplying steam for train heating.

The capacity of the locomotive is 1,800 hp. one hour rating, or 1,260 hp. continuous rating.

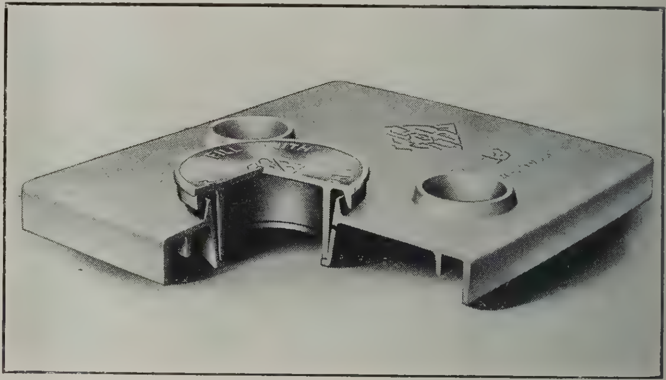
The locomotive was built for running on the main line, but at present trials can only be carried out on the Newport-Shildon branch, which has the same voltage which the locomotive is designed for.

The satisfactory result of the trial clearly indicated that the full horsepower for which the locomotive was designed could be developed. The test further proved that the heavy grades on this line could be dealt with in the manner anticipated. The results of the trial showed that, when this locomotive is put on the main line, it will be able to take the heavy passenger traffic up the grades at a higher speed than steam locomotives are able to do at the present time, and that it will be able to maintain a faster schedule without running excessive speeds on the level and down grade.

High Speed, 1500-Volt Direct Current Passenger Locomotive With Quill Gear Drive for the North Eastern Railway

Improved Cover for Rubber Battery Jars

Announcement is being made by the railway department of the Electric Storage Battery Company of an improvement in the design of the lead antimony battery cover manufactured by that company. This cover is for use on the so-called rubber battery jars which are termed Exide Non-Conductive Containers by the Electric Storage Battery Company.



Lead-Antimony Cover for Non-Conductive Containers

A flange has been placed around the bottom of the vent rim on the new type of cover for the purpose of preventing the splashing electrolyte from working up between the vent cap and the cover.

Six Track Trunk Line of N. Y., N. H. & H. Electrified Zone.

New Single Phase Equipment for the New Haven

Two Master Controllers Installed in Trail Cars Permit Operation From Any Car in Train

By Walter H. Smith
Railway Equipment Engineer, Westinghouse Electric & Mfg. Co.

THE New York, New Haven and Hartford electrification has been in operation since July, 1907, and at present comprises 83 miles of route with 570 miles of electrified track. In February, 1910, the first regular multiple-unit train service was put into operation

N. Y., N. H. & H. Multiple-Unit Car Fully Equipped

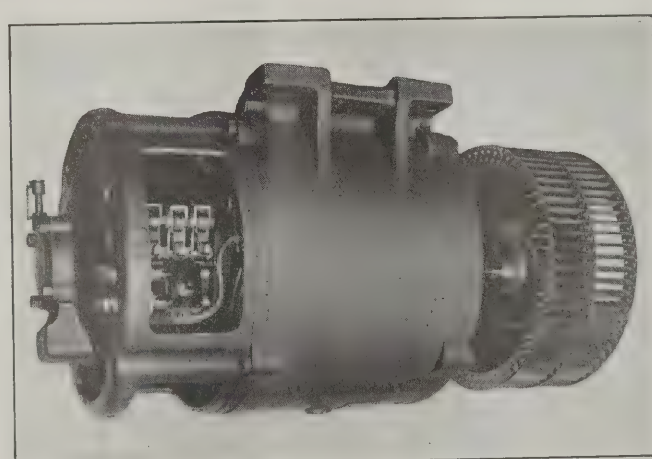
between Port Chester and New York. The equipment at that time consisted of four motor cars and six trail cars, each motor car being designed to handle two trail cars. This electrification has expanded until it now represents one of the largest single-phase electrifications of a steam railroad and is one of the most extensive examples of multiple-unit and locomotive service in operation today. In this electrified zone there are at present 106 locomotives, 27 motor cars, and 50 trail cars. This railroad recently placed an order for 8 new motor cars and 14 trail cars which makes a total of 35 motor cars and 65 trail cars in service. This new equipment is now in operation. The table following gives some of the principal dimensions of the new motor cars:

Length over buffer face plates	71 ft. 11 in.
Length over buffer channels	70 ft. 7 in.
Length over end sills	61 ft. 4½ in.
Distance between truck centers	47 ft. 7½ in.
Wheel base of motor truck	8 ft. 1 in.
Wheel diameter	42 in.
Height from top of rail to top of car	13 ft. 3½ in.
Weight fully equipped	177,000 lb.
Seating capacity	84

The trail cars have the same dimensions except as follows:

Wheel base of truck	8 ft.
Wheel diameter	36 in.
Weight fully equipped	103,000 lb.

Like most of the other New Haven multiple-unit cars,

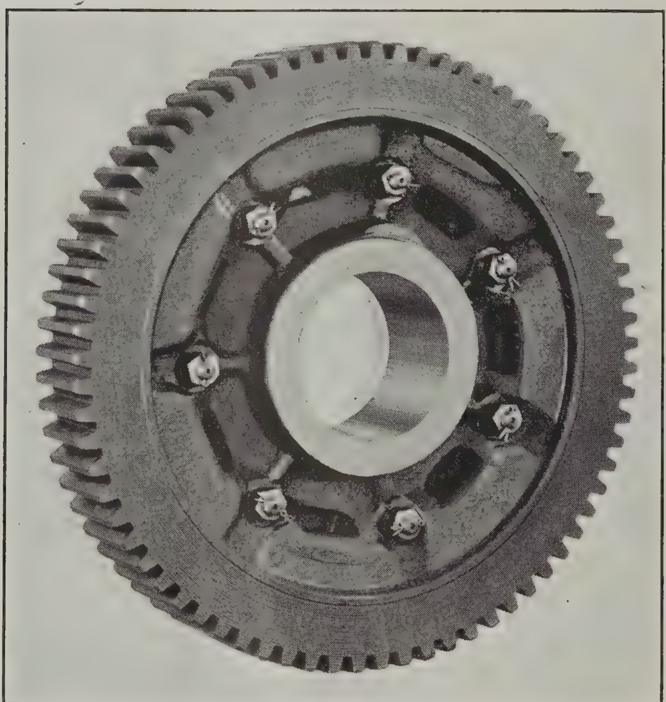


Type XB-45-N Blower Motor and Fan

the new equipment has series motors for operation on both alternating and direct current. When operating over the New York Central tracks the direct-current system is used and power is taken directly from the third rail

through collecting shoes, while on the New Haven and New York Connecting Railroads, the alternating-current system is used and power is taken from an overhead trolley wire at 11,000 volts. It is then reduced by means of a transformer to the voltage required for the main motors and other auxiliary apparatus on the car. The main motors are permanently connected two in series and the groups may be connected in series or in parallel for d. c. operation.

The new motor car equipments (excepting two) will employ four 175 hp. (hour rating) Westinghouse type 409-D single-phase, 25-cycle, series motors. The frame is a one piece steel casting of box construction. At the ends are large machined openings for receiving the bearing housings and to permit the removal of the armature. The armature is of the drum type, lap wound, coils cross connected and with resistance leads between the commutator bars and coil leads. The spur gears are of the flexible



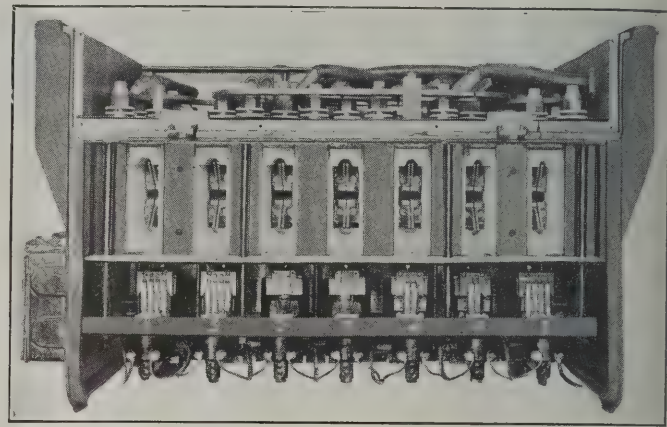
Flexible Gear Assembled Complete

type, the ratio being 27:73. The rims of these gears are made from high grade steel forgings, accurately machined with a 5¼-in. face. The gear is pressed on and without key.

The new equipment was designed for multiple operation with the cars already in service. All of the trail cars are equipped with two master controllers duplicates of those on the motor cars, a control train line and the necessary details for operation of the train from a trail car as well as from a motor car. This permits the operation of a trail car at the head of the train when desirable.

The Westinghouse type "HB" (hand operated battery) electro-pneumatic multiple-unit control system is employed. The energy for operating the magnet valves of the control and auxiliary apparatus is taken from a motor-generator set and storage battery at 30 volts. The storage battery consists of 25 Edison type B-4-H cells connected in series.

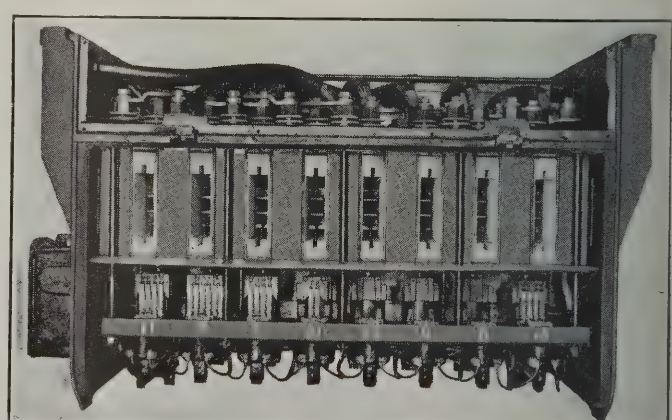
The motor cars are provided with two sliding shoe pantagraph trolleys, having automatic, self adjusting action to conform to various trolley wire heights such as are encountered under bridges and along the open line. The pantagraph is raised and held in position by spring pressure and is lowered by compressed air from the controller reservoir. These cars are also provided with four pneumatically operated third rail shoes. These shoes are located on each side of the trucks on wooden beams and are used when operating in the direct-current zone over the New York Central tracks. The operation of



Front View of Type 269-A-3 Switch Group, Covers Removed

both pantagraphs and third rail shoes is controlled from a push button set located in the motorman's compartment and two magnet valve sets located under the car body.

The main motors are protected from overload and short-circuit when operating in both the alternating and direct-current zones. When operating in the direct-current zone the usual standard series type of overload relay actuating the line switch is employed for this protection, while in the alternating-current zone an oil circuit-breaker is employed. This oil breaker is provided with a time element relay to delay its opening on an overload,



Front View of Type 268-A-2 Switch Group, Covers Removed

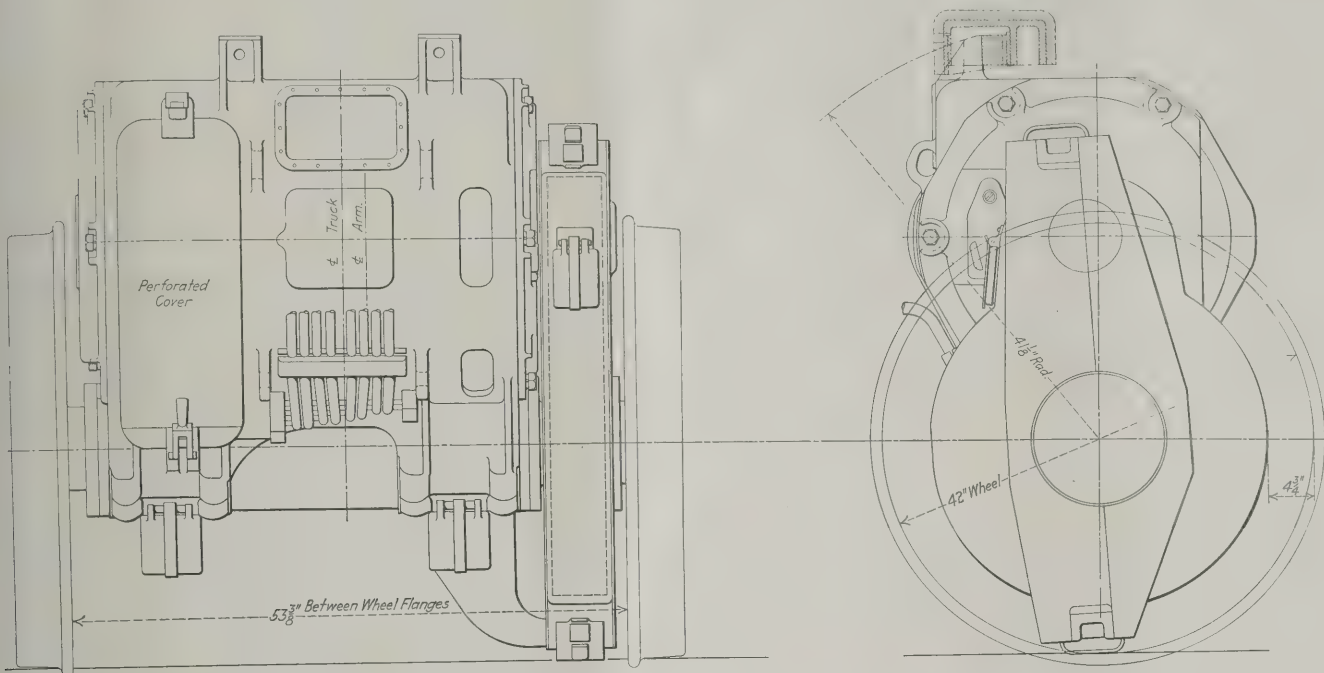
ground or short-circuit until the line has been cleared by the power house breaker. The high tension side of the main transformer is then disconnected from the trolley. This time element relay is controlled from a series transformer inserted in the high tension lead of the main transformer between the oil circuit breaker and pantagraph.

The main transformer is of the standard railway air blast type. The laminations are built up closely around the assembled coils with inter-leaved joints and clamped

tightly between cast steel end frames. The transformer is provided with ventilating ducts and is cooled by the flow of air from the blower system. The ventilating air enters the low tension end of the transformer and is discharged at the high tension end. The ventilating system will be described later.

The control system employs 15 electro-pneumatically operated switches assembled in two groups of seven and eight switches respectively. Most of these switches are used for both alternating and direct-current operation. There are seven acceleration points for a. c. operation and thirteen acceleration points for d. c. operation. The sequence of switches is arranged so that the grids are correctly and efficiently employed for both kinds of power.

There are two reverses of the drum type, one for each group of two motors in series. These devices govern the direction of flow of current through the main motor fields with respect to the armatures and accordingly determine the direction of armature rotation and consequent forward or reverse movement of the car or train. The drums are rotated from one position to the other by means of two opposed air cylinders which are provided with magnet valves. The control circuits governing these



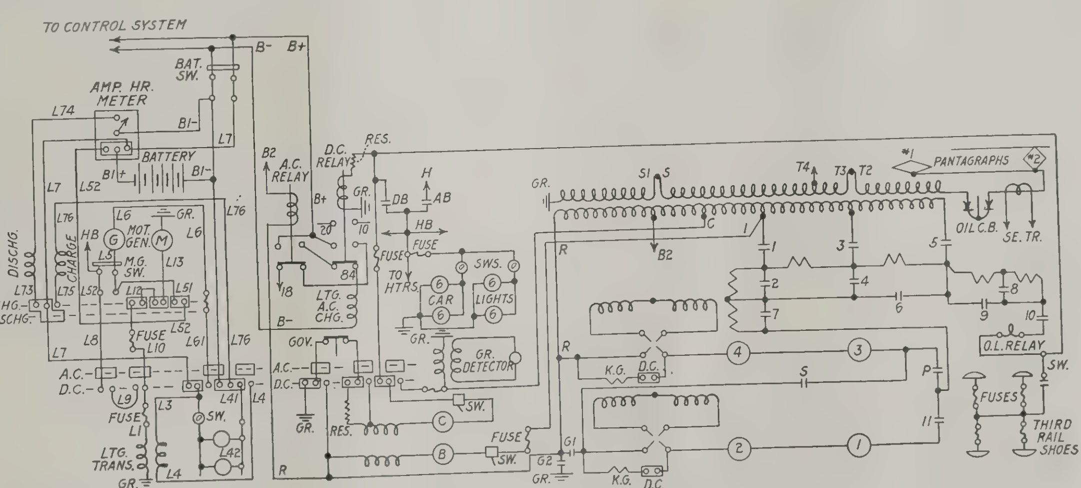
Outline of the Type 409-D Single Phase Motor Showing Over-all Dimensions and Clearances

SEQUENCE D.C.

STEP	2	4	6	7	8	9	10	11	P	S	G2	G1
1							O	O		O	O	
2					O		O	O		O	O	
3					O	O	O	O		O	O	
4	O				O	O	O	O		O	O	
5	O	O			O	O	O	O		O	O	
6	O	O	O		O	O	O	O		O	O	
7	O	O	O	O	O	O	O	O		O	O	
					O		O	O		O	O	
					O		O	O		O	O	O
8					O		O	O	O		O	O
9					O	O	O	O	O		O	O
10	O				O	O	O	O	O		O	O
11	O	O			O	O	O	O	O		O	O
12	O	O	O		O	O	O	O	O		O	O
13	O	O	O	O	O	O	O	O	O		O	O

SEQUENCE A.C.

STEP	1	2	3	4	5	6	7	11	P	G1
1	O							O	O	O
2	O	O						O	O	O
3*	O	O					O	O	O	O
4		O	O				O	O	O	O
5		O	O	O			O	O	O	O
6		O		O	O		O	O	O	O
7		O		O	O	O	O	O	O	O



Schematic Diagram of Connections—Main Control and Auxiliary Circuits for the 409-D Motors

switches are of the standard railway construction and are provided with blow-out coils.

The main circuit arrangement requires only one set of girds for acceleration on both alternating and direct current. These girds are assembled into fixed frames and suspended from the underframing of the car body. By the use of the a.c.-d.c. control changeover switch the drums are interlocked with the switches so that power cannot be applied to the two motors controlled by a drum, unless the latter is in the correct position for movement of the car or train in the direction indicated by the reverse handle of the master controller.

The wires comprising the control train lines are run throughout the entire length of both motor and trail cars

and are connected between cars by means of jumpers. Each car is provided with a switchboard panel located in a cabinet in one of the vestibules. This panel board has mounted on it all of the control switches for the lighting and auxiliary apparatus that are required by the system.

Both motor and trail cars are provided with independent main and auxiliary lighting systems. These lighting systems are protected by fuses in the panel board cabinet and comprise 36 lights, the auxiliary row down the center of the car and a main row down each side of the car. Each side row consists of two circuits, each containing six 25-watt, 110-volt lamps connected in series, and the center row is a single circuit of twelve 25-watt, 32-volt lamps connected in parallel. The main lighting circuits receive power direct from the line on d.c. and from the main transformer on a.c. The auxiliary or center circuit is supplied with current from a 500-watt lighting transformer at 32 volts, when the car is operating in the a.c. zone and from the storage battery when operating in the d.c. zone. The changeover is automatically made when passing from the d.c. to the a.c. zone and vice versa. The battery charging system is provided with an ampere-hour meter and disconnecting switch, so that when the battery has been fully charged it is automatically cut off from the motor-generator and the motor-generator disconnected from the line.

The ventilating system for cooling the main transformer and motors is supplied from a blower. The ventilating air is taken into the system through louvres at the sides of the car and is delivered by the fan to a longitudinal air duct (formed by the center channels of the car body and top and bottom plates) through which it is distributed to the intakes of the transformer and main motors.

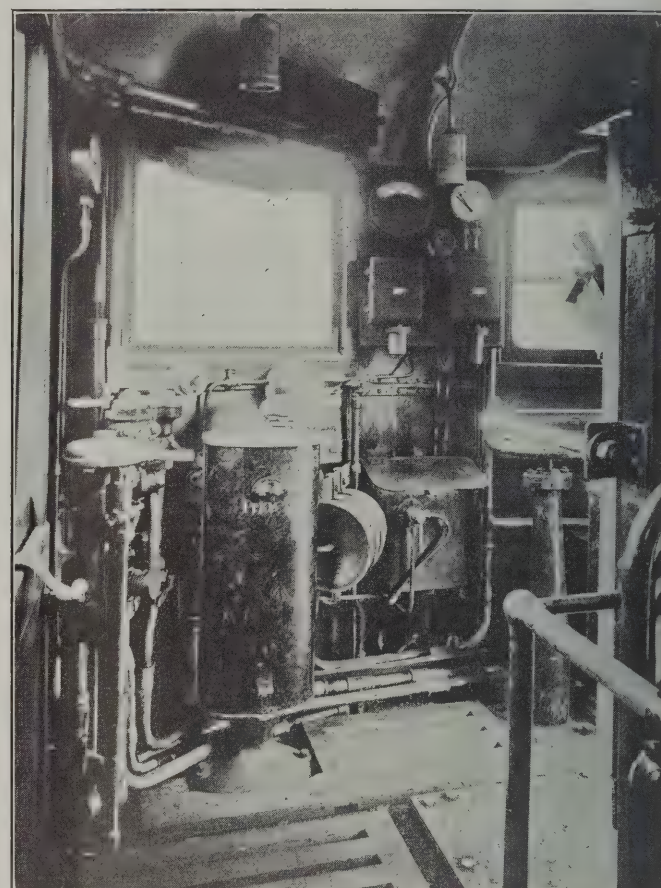
The blast wheel of this blower unit is a double inlet wheel 20 inches in diameter mounted on the shaft of its driving motor. The blower unit is mounted near the center of the car body and is suspended from the under framing. The motor is the series type and is supplied with current at 380 volts from taps on the main transformer and runs at a speed of 1,400 r.p.m. The blower unit is not used when the car is operating over the New York Central tracks in the d.c. zone.

Photo Copyrighted by Underwood & Underwood, N. Y.

Docks and Railroad Terminal at Tampico

Passenger Locomotives Rebuilt for English Railroad

THE Metropolitan Railway in England has recently made alterations in track layout on its electrified section which makes it possible to run a number of trains without a stop from Baker Street to Harrow-on-the-Hill, a distance of nine and one-half miles. The greater part of the electric train service includes many stops requiring locomotives with large starting effort and moderate running speeds. The new service requires also high speed and for this purpose 20 locomotives are being reconstructed. Six-car trains are used weighing with passenger load about 180 tons and with the locomotives 240 tons. The locomotive has a 0-4-4-0 wheel arrangement and is equipped with four 300 hp. motors.



One of the Two Driving Compartments

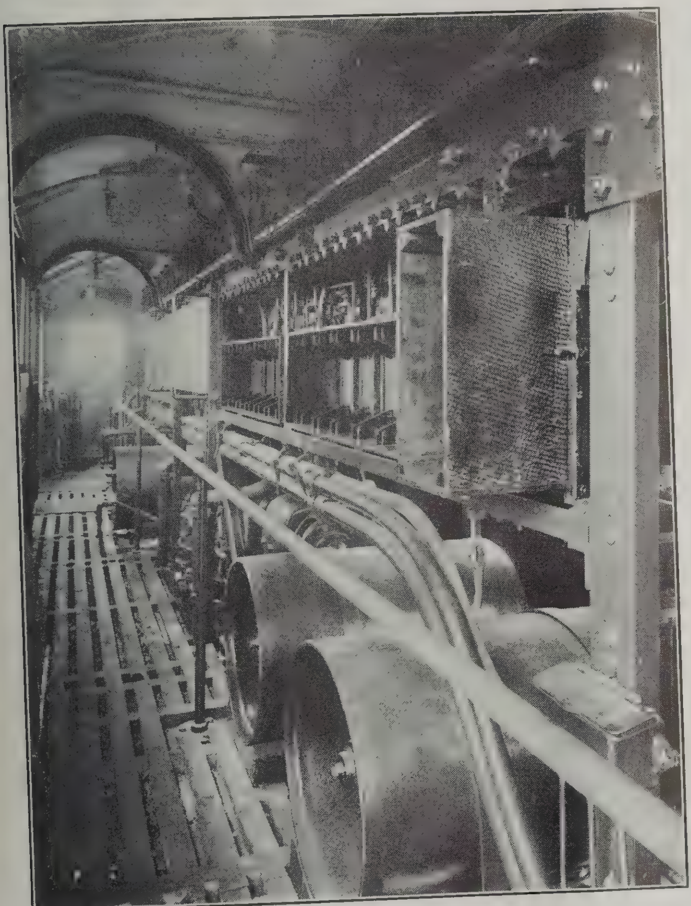
According to American standards the train is light, but the power of the locomotive is proportionally large.

The cost of coal in England has made the consumption by electric trains a matter of greater importance than it was at one time and careful tests have been made to ascertain the performance of the locomotives. Automatic acceleration is used as it increases efficiency of operation when train weights are fixed as they are in this case. Tests showed the power consumption to be under 55 watt-hours per ton mile. Complications of design are avoided in the reconstructed locomotive as regenerative braking is not required and the total amount of power used is not extremely large, permitting the use of self-ventilated motors.

There are four series-wound, commutating pole motors

on each locomotive. Each is rated at 300 hp. at 600 volts on the one hour rating, the corresponding locomotive speed being 30 miles an hour. The maximum speed of the locomotive on the non-stop runs is about 60 miles an hour. The motors are the largest it was possible to have with the standard rolling stock wheel which would at the same time conform to regulations for clearance between track level and the bottom of the motor and the gear case. The magnet frame is of the box type cast in one piece and provided with the usual arrangement of suspension bearings from the running axle and with a nose support at the other end. The running wheels are of the disc center type having brake blocks acting on both sides of the rim. The truck frames consist of plate frames stiffened with cast steel corner castings.

Vacuum brakes are used on the coaches while the locomotive is equipped with vacuum brakes and Westing-



Interior of Locomotive Cab showing Accessibility of Control Apparatus

house air brakes. These are interlocked with the controller so that unless one or the other of the two brake systems are operative, power can not be applied to the motors. The Westinghouse brake is used generally for switching in the yards and the vacuum brake for operating the train.

Direct current power is supplied to the locomotive at 600 volts on the third rail system and an insulated return rail is laid in the center of the track. The running rails are not used for the return and carry only signal circuits. There are four positive and two negative collecting shoes on the locomotives; the positive shoes being in duplicate, one set of two being placed on each side. The negative shoes are on the center line. Collecting shoes are also fitted to some of the coaches which are connected to a power bus line carried through the train to enable the train readily to pass over breaks in the collecting rails. Two or more locomotives can be coupled together and driven in multiple unit from one cab.

There is a driver's compartment in either end of the locomotive. The control apparatus, including contactors, resistances and auxiliary machinery are arranged in a group placed along the center line of the locomotive. This arrangement provides a runway on each side which facilitates inspection and the making of repairs. Side louvres are provided in addition to roof ventilators. The cab windows are provided with automatic window wipers for use in wet weather.

PRINCIPAL DIMENSIONS

Length over buffers	39 ft. 6 in.
Length over body	35 ft. 0 in.
Width over body	8 ft. 0 in.
Height from rail	12 ft. 4¼ in.
Centers of motor trucks	20 ft. 3 in.
Wheel base of motor trucks	9 ft. 3 in.
Total wheel base	29 ft. 6 in.
Diameter of running wheels	43½ in.
Gear ratio	26/54
Capacity of motors	300 hp.
Total hp.	1,200

The mechanical work on the locomotives is being done at the Barrow Works of Messrs. Vickers, while the electrical equipment is being supplied and erected by the Metropolitan Vickers Electrical Company, under the direction and supervision of Charles Jones, chief locomotive and electrical engineer, Metropolitan Railway Company.

One of the Reconstructed Locomotives for the Metropolitan Railway

An indication of the amount of business now being handled by railroads is given in the report of the American Railway Association on car loading. This report shows the number of cars loaded with revenue freight for the week ended July 1, the last week before the 10 per cent reduction on freight rates took effect as well as the last week before the shopmen's strike, was 876,896 which was an increase of over 100,000 as compared with the corresponding week in 1921 and only 14,725 less than the loading for the corresponding week of 1920, the reason for which is indicated by the fact that in May of this year coal loading was 98,286 cars less than in 1920.

View of North Side of North Track Showing Elevated Runway Used by Rivet Burners and Backout Men.

Cutting Steel Car and Locomotive Boiler Rivets

Alleged Disadvantages of Electric Rivet Cutting Discounted by Installation on Chesapeake & Ohio

By E. A. Murray
Shop Superintendent Chesapeake & Ohio, Huntington, W. Va.

FOR several years the practice of burning off rivet heads on steel cars with the electric arc has been in vogue at the Chesapeake & Ohio shops at this point. Recently this method was extended to locomotive boilers and we find that we can obtain equal success burning off rivet heads on boilers, as well as steel cars. For cutting rivets we use a General Electric motor generator set, Fig. 1, which consists of a 2,000-ampere, 80-volt, direct-current generator, direct connected to a 225-h.p., 440-volt, induction motor. This set is operated by a manually operated starting compensator, which is equipped with overload relay and no voltage release.

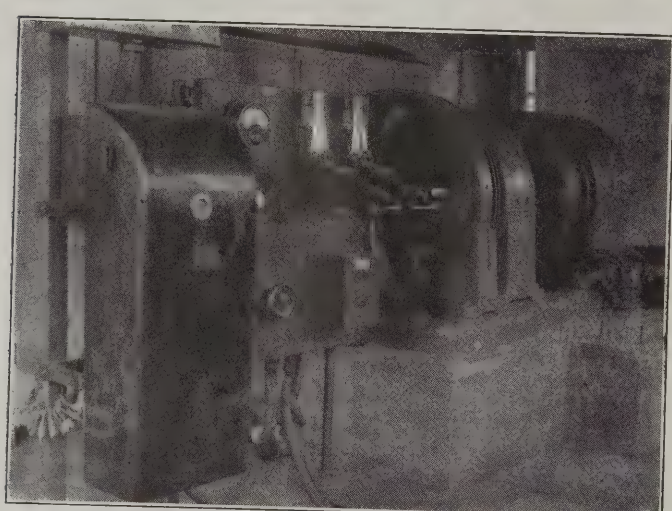


Fig. 1—Motor Generator Set and Control Apparatus

The slate control panel, 5 ft. 4 in. by 3 ft. 4 in. in size, is equipped with an ammeter of 3,000 amperes rating, a 0 to 120 voltmeter, a polyphase watthour meter, circuit breakers and a rheostat for adjusting the voltage of the welding generator.

The rivet-burning tracks are situated about 10 ft. from the generator room. They consist of two tracks about 5 ft. apart and are 450 ft. long, Fig. 2. The rails are bonded at each joint with No. 0000 rail bonds. In addition to this the four rails are bonded together by one-half in. by 3 in. iron bonds every 40 ft. Running between the two tracks and on the outside of each track is a substantial wood scaffold 6 ft. high, with a 3-ft. walkway which extends the entire length of tracks. These are used in cutting rivets which cannot be reached from the ground.

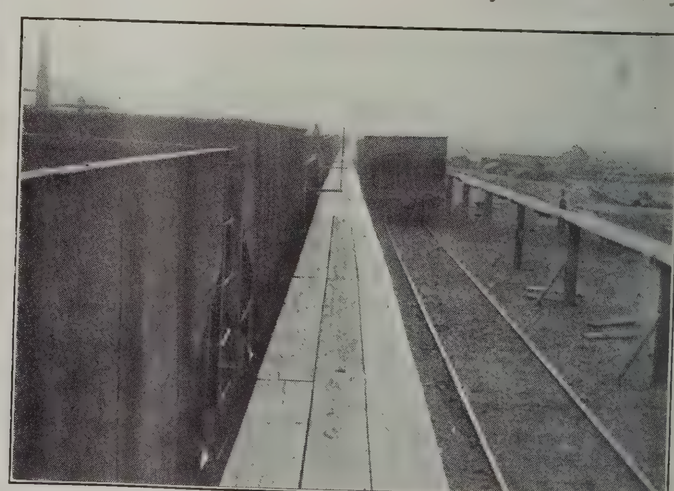


Fig. 2—There are Two Tracks and Three Elevated Runways

On the middle scaffold, directly beneath the walkway, there is a 1½-in. solid copper bar running the entire length of the platform. To this is connected at intervals of every 40 ft. a Cutler-Hammer, type T. C. grid resistance bar. These grids have a resistance of .04 ohms. and will allow each operator to use a maximum of 500 amperes. The feeders running direct from the control panel in the generator room consist of two 1,000,000 circular mil, slow-burning cables. These are run under ground in waterproof boxes. The positive line is connected direct to the bonded rails, while the negative side runs up to and is connected to the 1½-in. solid copper bar. The hesistance boxes are connected between this bar and the leads of the cutting electrodes.

The cutting tool, Fig. 3, is 35 in. long and is made of a piece of ½-in. square copper, which is about 1½ in.

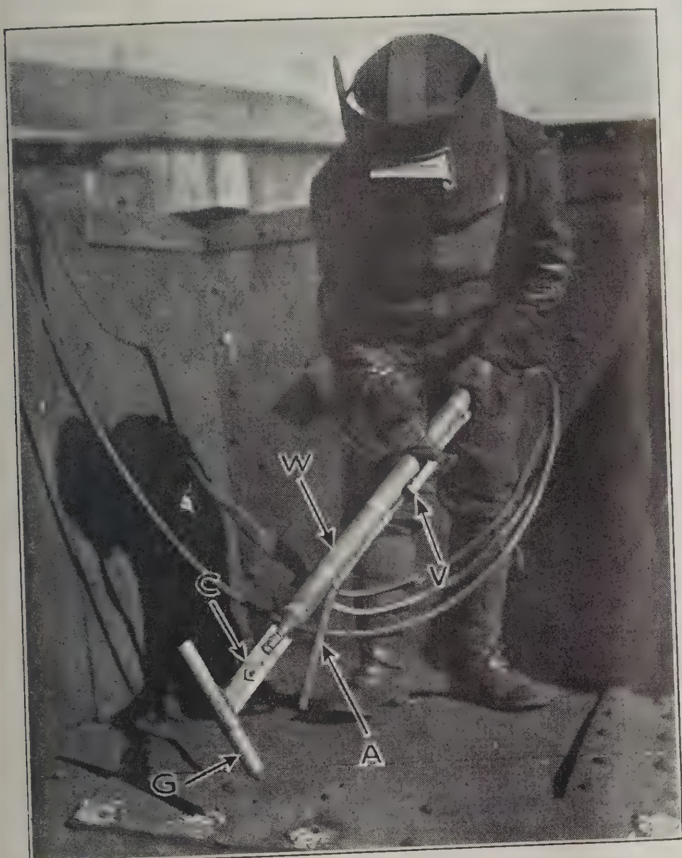


Fig. 3—Burning Tool in Use on a Horizontal Surface

on each end and threaded with ½-in. standard threads. The square part is covered the entire length with a round wood handle W, which is split in halves and grooved to fit the copper bar. The two halves of the handle are glued together, and, in addition to this, a metal hose clamp is placed on each end. To one of the threaded ends is screwed a female brass connection. This connection is cast in the shape of ¾-in. rod; it is 4 in. long, one end being tapped ¾ in. deep with ½-in. standard thread. The other end has a 5/16-in. slot in it 3 in. long. Through this are drilled two 5/16-in. holes for bolting two ⅛ in. by 1 in. by 6 in. clamps, *C*, which have the ends forged to fit graphite sticks, G, 1 in. in diameter. These clamps also have a 7/16-in. hole drilled about 2 in. from the end for a ⅜-in. bolt, by which the carbon is tightened in the clamp. The clamps are forged on the end so that when the cutting tool is in a horizontal position the carbon is at an angle of 45 deg. The total weight of this tool is 4½ lbs. Connected to each resistance box by means of copper terminals are two No. 2 General Electric flexible arc welding cables 50 ft. long. On the other end is soldered a female connector, which screws into the cutting tool. When the operator finishes cutting on one car, he unscrews his tool and goes to the next car, where he can attach the tool to the next lines. This does away with the work of carrying the heavy leds from place to place.

We get the best results with about 500 amperes and 55

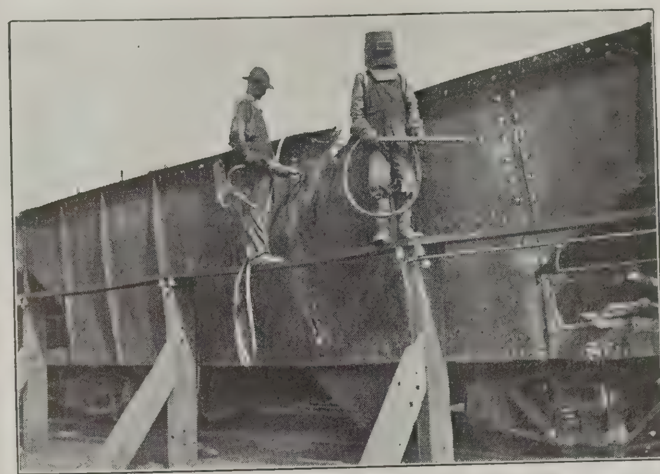


Fig. 4—After the Rivet Heads Are Burned Off the Rivets Are Backed Out With a Pneumatic Tool

volts at the arc. An operator easily cuts four 1in. rivet heads in a minute and averages about 1,000 rivets in eight hours.

For cutting rivets on the bottom of cars or flat surfaces a ⅜-in. air pipe A, Fig. 3, is attached and so bent that the end points directly at tip of the carbon. The flow of air is controlled by a small push valve, V, on the side of the tool handle. When the operator makes an arc on a rivet in the floor and the metal starts to run, he pushes

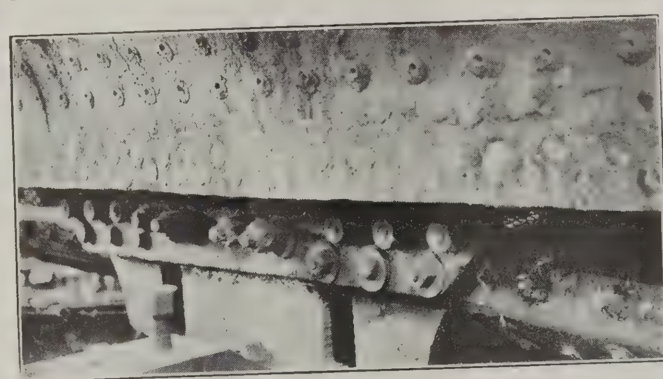


Fig. 5—Locomotive Fire Box. Rivet Heads on Mud Ring Have Been Burned Off

the valve and the air jet blows the molten metal away, making a clean cut.

At present we are using 10 operators in cutting steel car rivets. We formerly used carbon sticks in the rivet burners, but on account of the great durability of the graphite sticks, we discontinued the use of the carbon

We find that the graphite sticks burn off from five to six times as many rivets as the carbon and give considerably better service. The carbon electrode will heat over its full length and in some cases burn the holder, while the

graphite heats only about 2 in. from the end on which the arc is produced and does not burn the holder.

Our records show that a saving of 50 per cent is being made in doing this work by this process. This work was formerly done by using rivet busters which were found to be unsatisfactory, especially is this true when the car sheets are thin and badly deteriorated. This method has proved so satisfactory that it has also been applied in the locomotive department. An example of the work done is shown in Fig. 5.

The Status of Railroad Electrification*

The Reasons for the Railroad Man's Apparent Reluctance Toward Adopting Electric Motive Power

By Calvert Townley
Westinghouse Electric & Manufacturing Company

WHEN we electrical engineers have discussed railroad transportation we have always done it from the standpoint of proving how desirable it is for the steam railroads to electrify, and when we have invited our steam railroad friends to participate in our discussions, they usually refrain from courtesy or some other reason from telling us absolutely and entirely what they think of us. It has therefore occurred to me that it might be worth while for an electrical man to say a few words about the railroad man's natural objections to electrification and to give some of the reasons why he is not always willing to fall upon our necks and welcome us as saviors.

Having enjoyed for many years an association with the big railroad system which serves this community, I have had an opportunity to learn something of the railroad man's point of view from the inside.

Electrification Expensive

In the first place, electrification is very expensive. It involves not a small but a tremendous addition to the investment per mile, with the consequent difficulties not only of earning the additional interest charges thereby involved, but also those of financing—of raising the money. These are by no means minor objections. The day has gone by when the management of a railroad property can have a free hand in issuing securities. Through their various governmental agencies the public has established a strict supervision over railroad earnings, is reluctant to permit the capitalization of values created by earning power and is prone to regard railroad securities as having so stable a value that their yield must be limited to a minimum annual interest with little opportunity for the stockholders of the road to obtain large profits from courage and initiative; that is to say, stated in another way if a railroad by far-sighted and wise expenditures should be able to earn a rate of return such as is freely permitted and often applauded in private industry, such for example as 15 per cent to 20 per cent per annum, it is most probable that this additional yield would be shortly taken away from it by a forced reduction in its rates. I am one of those who believe this public policy is founded on a misconception; is in fact practically an economic crime, because I think it is obvious that if a dollar invested in a railroad is not permitted as good a chance as one invested in a shoe factory or a flour mill, that dollar will tend to go into the factory or mill and not into the railroad, with the consequent hampering of that continued improvement and expansion of our transportation facilities so necessary to progress. I cannot escape what seems to me to be the obvious logic that if it be equitable for the public to prescribe a maximum rate of return on a railroad or any other investment, it should, as a necessary corollary, guarantee the same investment not less than a minimum return. However, our public policy has been pretty firmly established by now so that what I think about it is of only academic interest.

The art of estimating in advance the cost of new construction, no matter if practiced by the most competent engineers, has never reached or even approached perfetcion, therefore, where such large expenditures as those necessitated by electrification are contemplated it is always possible due to this fact and due to unforeseen contingent expenses that the estimated costs will be considerably exceeded. A combination of this contingency with the knowledge that should greatly increased profits result, the road may be deprived of them through the medium of rate reductions, may well cause the responsible executives to go slowly.

Departmentalization

Long experience has demonstrated the necessity and established the practice of well-defined and rather rigidly restricted departmentalization of railroad construction and operation; that is to say, the construction, operation, traffic and financing are each in charge of a responsible official who concentrates his attention each on his own department and who is most punctilious in keeping out of every other sphere. This practice results of course in a high degree of efficiency in the conduct of each department and is obviously dictated by a wise policy. However, it has the disadvantage of dividing the responsibility for general results and makes for a tendency to put departmental success ahead of general prosperity.

Substitutes an Unlimited Motive Power

Electrification upsets some of the fundamentals around which steam railroad practice has been built up, namely, it practically substitutes an unlimited for a limited motive power. This fact is well known to us all but it is so fundamental and so far-reaching in effect that it will bear restating and emphasizing many times. I refer of course to the fact that a steam locomotive which carries

*Address delivered before the Connecticut Section of the American Institute of Electrical Engineers, May 23, 1922.

along its own boiler and is therefore in fact its own power house is limited in the tractive effort it can exert by the steam which can be generated by that boiler, whereas the electric locomotive being only a translating device can call upon the entire capacity of all the power houses connected to the system. On account, therefore, of the large excess in such power house capacity over any possible demands of an individual train, on account also of the characteristic of electric motors to continue to exert more and more power, even to the point of self-destruction, and further on account of the possibility of operating two or more electric locomotives together in absolute synchronism with one crew and the consequent possibility of getting any desired weight on the drivers, there is practically no limit to the amount of tractive effort that may be utilized for any one train.

The consequences resulting from these facts are rather startling, for example, the long-established and accepted practice of calling two per cent the maximum grade over which a desired schedule may be made goes into the discard and much steeper grades become entirely practicable, likewise the tonnage and speed of freight trains previously limited by the power of a steam locomotive to pull is no longer so limited. Freight trains may be as long as the structural strength of the freight cars will permit or as may be handled in the yards and on the sidings. Schedule speeds may be increased to any point considered safe for the track and equipment, being no longer limited by the steaming power of the locomotive. Instead of accelerating from a standstill at the rate of one-quarter of a mile per hour per second as is common steam locomotive practice, passenger trains may be accelerated at the rate of from one mile to one and one-half miles per hour per second.

We have always considered the above fundamental change as offering a wonderful opportunity for the improvement of traffic and they do offer such improvement but to get all the possible benefits requires the co-operative effort of the construction, operating and the traffic departments. It disturbs the existing order to a very considerable extent and redistributes the proportionate burden of expense among the different departments concerned so that any departmental head may be faced with the necessity of taking on some additional burden in his own department without any compensating advantage, *i,e.*, the advantage goes to another department. In view of the well-established relationship between departments above referred to, railroad executives cannot be blamed if they regard such innovations, with skepticism and retain a considerable reluctance toward their adoption.

Labor

The relation between railroad management and railroad labor is a source of continued and great anxiety. Owing to the meddling (and I use the word "meddling" deliberately and advisedly) of federal and other outside agencies in what may be well-meaning but is certainly a misguided effort, there has grown up an inflexibility in both the duties and the pay of railroad labor unparalleled in any other industry. Changes in operating methods are very difficult. Now electrification immediately requires a lot of changes. Not only have the engine drivers all to be educated to a new art but the duties of the fireman are revolutionized. In fact, except as a source of insurance against the death or disability of the engineer while driving his engine, the fireman is not needed at all. A new type of man, the electrical lineman and the electrical shop man is required and where a railroad operates its own power houses the power house crews are introduced. The transmission lines overlap two or more divisions of the road and confuse the duties of the division superintendents. The signal system has to be revamped. These and other features all tend to upset the existing order of relationship between the management and its labor, and the official whose duty it is to regulate these relations may be forgiven if he contemplates with extreme alarm the task presented to him.

Many if not all of the bunkers which I have mentioned are present on every railroad and you will note are not removed, even if it is known that railroad electrification would be advantageous. On top of this come all the questions of the actual virtue of electrification itself. It is perfectly true and I think now very generally admitted that all electrifications heretofore made have been successful and that no road which has electrified would now consent to return to previous conditions.

However, not more than about one per cent of the entire steam railroad mileage of the United States has been electrified as yet and the average railroad executive may be excused if he looks upon the existing examples as special cases and therefore as proving nothing with respect to his own particular problem. For example, the New Haven and the New York Central had to electrify out of New York City because of a law passed by the State of New York. The Pennsylvania had to electrify out of New York City in order to operate its subway river tunnels. The Norfolk & Western had a peculiar restricted neck to its bottle in the Elkhorn grades which would justify almost any expense to remove. In a like manner some special reason can be found for almost every large electrification project. However, it is perfectly safe to say that the attitude of mind of the railroad man has materially changed so that the question always first asked some years ago, "Can it be done?" has now been replaced by the entirely different question, "Will it pay?"

As many of you know, I have been and still am a consistent and an enthusiastic advocate of steam road electrification. In reciting the different objections of which I have spoken I do not intend in any way to indicate a change of opinion or a weakening of confidence but rather because I think it helpful to us all when we can look at any situation from the other man's point of view and because I firmly believe we can do the cause of electrification no greater harm than to ignore plain facts and out of well meaning but mistaken zeal advocate electrification where we are not reasonably sure that it will be economically right.

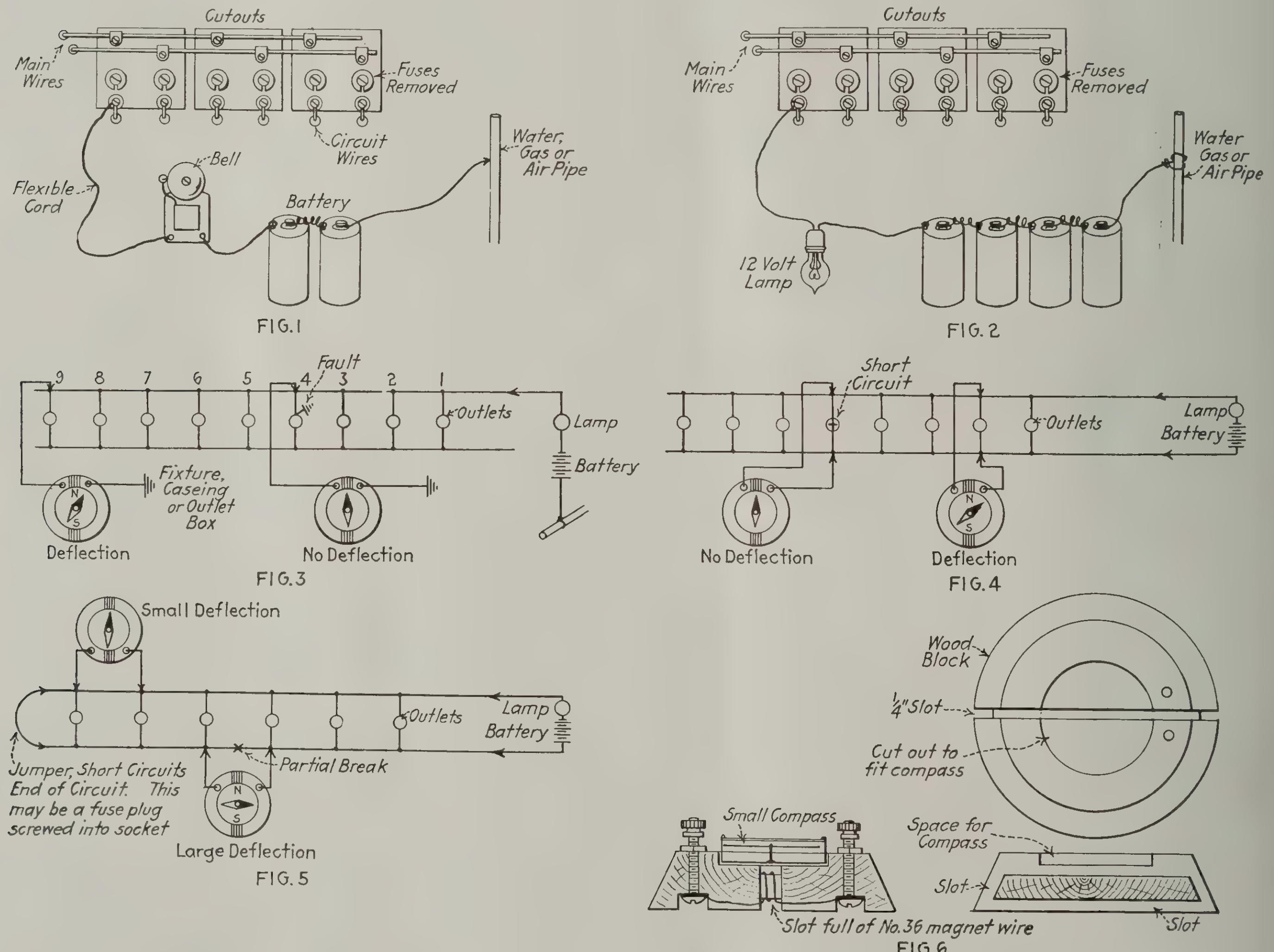
Maintenance of way forces on the Pennsylvania had an unusual demand made upon their time early in July in being required to build about one and a half miles of wagon road to enable consignees of watermelons and other perishable freight at New York City to reach delivery tracks on Newark Meadows, five miles from New York City, the destruction of a drawbridge by a steamer on June 22 having made the regular highways impassable, and heavy rains having prolonged the condition. The cost of road building was about $15,000.

THE INTERCHANGE

Simple Methods of Locating Short-Circuits, Open Circuits and Grounds on Car Lighting Wiring

By A. H. Matthews

First of all this is for the information of beginners, yard men in particular. To start with, you do not require any expensive and complicated apparatus—the more complicated the testing apparatus, the longer it takes and the harder it is to locate the trouble. (Electricians please note.)



Diagrams Showing Ways of Applying Various Tests

In the first place, car wiring is very simple. The apparatus required is a bell, four or five dry cells, an Edison base socket with 18 in. flexible leads, a galvanometer or a low reading voltmeter (that is, a meter that will give you a full scale deflection of about one volt or less), 50 ft. single strand flexible cord, 50 ft. double strand flexible cord, 12-volt Edison base lamp. For ease in testing, attach testing clips to the ends of the cord.

Now we will suppose that there is a very heavy ground, say, on the night lights. This is first tested by connecting bell and battery in series, and testing each circuit as shown in Fig. 1, first removing all fuses and opening the battery switch so that all wiring is "dead." When the bell rings we know that the ground is on this circuit, the

question is—where? You could trace it by opening up all the fixtures, but this takes time. One way, in the case of the fixtures are combination gas and electric, is first to remove all the lamps in the defective circuit, connect the 12-volt lamp and battery between the defective side of the circuit and the water or gas pipe, as shown in Fig. 2. The lamp will then light up *dimly*. Now go over all the outlets in the defective circuit with the galvanometer, connecting one lead to the casing of the fixture, or outlet box, and testing with the other to the center and outside connections of each socket separately. If a fixture or the wires near it are "clear," there will be a deflection; if grounded, little or no deflection. To further illustrate the method of locating the ground, see Fig. 3. If there are four sockets, and one of them is grounded, then all the other sockets in that fixture will show a small deflection except the one at fault. A ground in a socket may be caused by several things. A loose screw touching the shell, or a strand of the wire (which should be soldered to prevent this); also water leaking through the roof, might cause a slight ground.

A short circuit is found in the same manner except the lamp and battery are connected across the two leads of the cutout, and each socket tested by touching both socket connections with the galvanometer leads, Fig. 4. If the fixture is clear thhere will be a deflection. Start testing at the outlet nearest to the cutout, and work away from it. There will be no deflection at the defective outlet. An open circuit is located somewhere between the points where lights are burning and where the lights are out, so it is hardly necessary to test in order to locate it. It is simply a matter of repairing the break. A partial break can be found as shown in Fig. 5, testing across the outlets and taking note of the reading as you go along. An extra large deflection shows the location of the break.

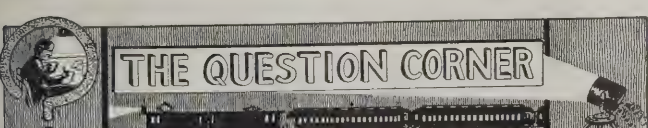
Fig. 6 shows three sketches illustrating one way of constructing a simple home-made current detector or galvanometer.

It's all right to aspire to control others, but have you begun with Number One?

Notice that two-thirds of "Promotion" consists of "Motion."

There is a better market for smiles than frowns.

The highest form of salesmanship is nothing but service.



Answers to June's Questions

1. *I have never noticed any questions pertaining to radio in the Railway Electrical Engineer, but I should like to ask your opinion on one or two points concerning this subject. What causes messages to fade away at times? Is a bright starlight night the best time to expect good results? How does daylight affect reception of signals? What effect does rainy weather have? What type of aerial do you believe to be most satisfactory? Are the best results secured when the radio wave strikes the aerial broadside or endwise? How far above a tin roof should the aerial be placed?*—M. M.

1. The subject of radio telephony has become so popular during the past year that we are surprised we have not had more questions pertaining to it before this. Wireless communication, while distinctly an electrical subject, differs in so many points from the more familiar characteristics of low frequency circuits, that most of the phenomena which accompany radio installations are not fully comprehended even by the more or less experienced electricians.

The following answers to the questions asked will probably clear up in the minds of many a number of points which have been giving some concern.

Atmospheric conditions exert a very great influence upon the range of a station and as these conditions change the phenomena of "fading" takes place. This is particularly true in the case of transmission over very long distances, where there is apt to be very different atmospheric conditions at different points between the transmitting and receiving stations. Just exactly what occurs in the atmosphere when signals fade is not altogether certain, as at present the data on this subject is not sufficient to warrant a specific conclusion, although it is believed that heat and humidity play an important part.

Starlight or moonlight are not known to have any effect on radio transmission. In the winter, clear, cold nights with bright stars are frequently conducive to excellent long distance reception, but this is usually attributed to the temperature and clarity of the atmosphere rather than to any condition relative to starlight or moonlight.

Daylight, however, does reduce the effective transmission range, particularly that of short-wave stations. Some observers have noticed that just prior to rain different stations can often be heard with unusual clearness, but that the signals fade away as soon as the rain begins to fall. Receiving stations located near transmitting stations are affected little or not at all by rainy nights.

For receiving purposes exclusively, the easiest type of outdoor aerial to install is a single wire from 100 ft. to 150 ft. in length. Not only is it easier to put up, but the reception is just as good as on any aerial having two or more wires. The horizontal part of the aerial should be supported as high above the ground as possible and the lead-in wire taken off at one end so that the construction resembles an inverted "L." Such an aerial has very little directional effect. Theoretically, the waves should strike the end of the horizontal portion to which the lead-in wire is attached first. In other words, the horizontal portion should point away from the transmitting station.

The horizontal part of the aerial should be placed as high above a tin roof as possible—20 ft. or more, if it can be put up that high. If the aerial is close to the tin roof, say within less than a foot, the signals from distant stations are liable not to be loud enough to detect.

Questions for August

1. *What is the principle of a tangent galvanometer and does it read current accurately?*

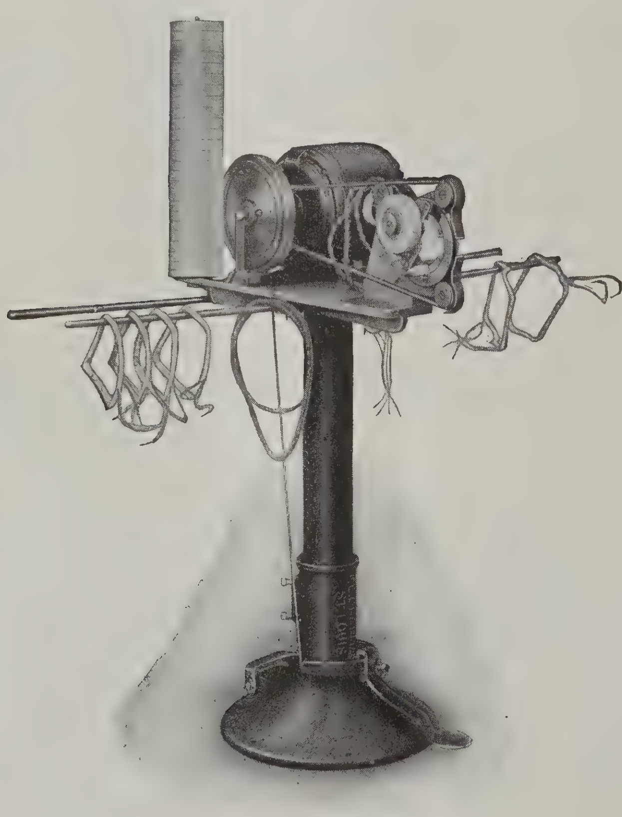
2. *What makes a pointer on a small d. c. ammeter stop quickly instead of oscillating before coming to rest?*

3. *Why is it that a Weston d. c. ammeter or voltmeter will not work on an alternating current circuit?*—C. R. E.

NEW DEVICES

Coil Taping Machine

The Chapman Electrical Works, St. Louis, Mo., has brought out a motor driven Taping Machine equipment which consists of an armature or field coil taping machine head as selected. Directly bolted to a very slow speed motor on which is mounted a cone clutch, giving instantaneous and fine adjustments in speed, responding to pressure on a treadle. This type of control is claimed to be better than an electric control.



Champion Armature Coil Taping Machine

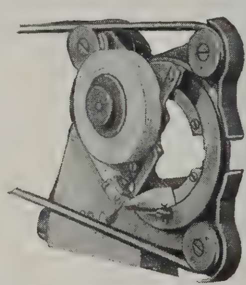
The continually moving member of the clutch is pinned to the armature shaft, which has enough end play to allow the clutch being disengaged. It is returned to open position by the magnetism of the motor, thus eliminating a thrust bearing and a spring.

A combined self-oiling cone driving pulley, brake pulley, and clutch member rides on an extension of the phosphor bronze motor bearing. It is active only when engaged, thus eliminating "loose pulley" bearings.

An automatic brake operated by the clutch treadle enables quick stopping and inching. A switch is provided, handy to the operator with plug and cord for direct current or single phase and with switch but no plug and cord for 3 phase.

Pins are provided for hanging the coils and for storing ten gross yards of tape. Ample clearance is provided for leads and for various positions of coils.

The outfit is self-contained, portable and when equipped with d. c. or single phase motors, may be operated from any light socket, making it possible to take the machine to the job. The height of the machine permits operator sitting on an ordinary chair.



Enlarged View of the Taping Head

Venting Protection for Renewable Fuses

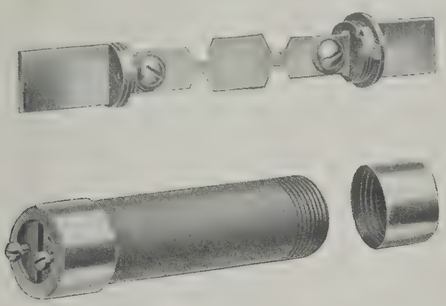
Reliability and economy in renewable fuses have been accomplished through the development of the fuse with the Shurvent construction by engineers of the Westinghouse Electric & Manufacturing Company.

This construction acts on the principle of baffles because it retards the flow of gas sufficiently to maintain enough pressure within the cartridge to extinguish the arc, and it also allows the gases to leave the fuse only after they have been cooled to a temperature that eliminates all hazard of fire or of personal injury.

Shurvent fuses have a series of fixed washers at each end of the casing. These washers are channeled to form

air chambers and they are connected to the inside of the casings, to each other and to the outer air by staggered openings. The hot gases will follow these courses more readily than along the threads, but they will be retarded sufficiently to accomplish two purposes—effective quenching of the arc in the casing, without damage to the casing itself, and cooling of the gases so that they will leave the fuse at a safe temperature.

The fuses in both the ferrule and knife-blade types have a specially designed long life bone fibre tubing, and the minimum number of parts assures ease of re-



Construction Details of Fuse

newing and obviates the possibility of losing parts that would make the fuse inoperative.

In the knife-blade type the links are solidly bolted to the copper terminals.

In renewing the ferrule type fuse the only parts to be removed are a cap and a washer from each end, while only one ferrule and the loosening of the screws at the other end are necessary in the renewal of the knife-blade type. These screws are permanently fastened to the end washers so that they cannot be dropped and lost.

Demand Attachment for Watthour Meter

For small power installations, which cannot use the more expensive graphic demand meter, or where the indicating type of demand meter is satisfactory, a demand attachment for use with a standard type OA polyphase watt-hour meter is being manufactured by the Westinghouse Electric and Manufacturing Company.

The attachment is a watt-hour meter register which combines the regular watt-hour meter register with the scale and pointers of an indicating demand meter. By replacing the register and cover of a standard polyphase OA watt-hour meter with this attachment and a special cover, the meter is converted into an indicating block-interval demand meter, which will indicate the maximum kilowatt demand and the integrated kilowatt hours with a negligible lapse of time between the measurement of adjacent blocks.

The demand attachment has two pointers, one white and the other black. The white pointer advances the maximum demand black pointer to any maximum demand position on the demand scale, where it is held by friction while the white one returns to zero at the end of each time interval. By watching the movement of the white pointer, which shows an integrated and not an instantaneous demand, the duration of the demand interval can be checked as well as the demand at the time of reading the meter.

After the gears driving the white pointer have been disengaged from the gear train of the watthour meter, the pointer is returned by gravity to zero. The time at which the gears are disengaged, and therefore the time interval of the attachment, is determined by an induction motor, which, although small, gives several times the torque necessary to release the white pointer, thus assuring the positive action of the attachment.

The motor has practically a constant speed over a voltage range varying from 90 to 110 per cent of the rated voltage, which permits the calibration of a meter in the laboratory and its installation on a line with a voltage variation of several per cent from the calibration voltage with no appreciable error in the length of the time interval of the demand meter.

The demand scale, which is 3¼ inches long, is marked directly in kilowatt demand, but the watt-hour dials are used with the register constant of 10 or multiples of 10, as with the standard type OA meter register.

Portable, Motor-Driven Wood Working Machine

An interesting motor-driven portable machine, designed to perform many different woodworking operations, known as the Flexway machine, has been developed by the P. L. Billingsley Company, Cincinnati, Ohio. This machine is made in two sizes, No. 1 and No. 2, for relatively light and for heavy work. In general, the driving motor and operating parts are mounted on a

Flexway Machine Equipped for Ripping with Rip Gage

small but sturdy four-wheel truck, which runs on a track the full length of the carpenter's bench. Work such as planing, dadoing, beveling, ripping and mortising can all be done with the same machine by simply attaching the required tool.

The mechanical connection between the tool and the motor is by means of a universal joint with the power transmitted by two belts. The weight of the parts is care-

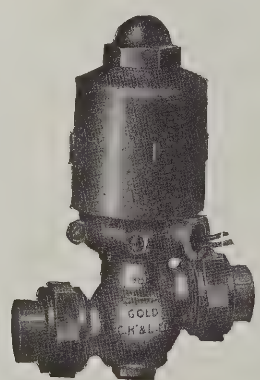
fully counterbalanced by means of two adjustable weights clearly shown in the illustration. It is stated that the machine is both accurate and powerful, enabling it to machine fibrous and knotty lumber with ease. All tool changes are made easily and in an average length of time not exceeding a few seconds.

While the Flexway woodworking machine is ordinarily mounted on tracks it has been found convenient for certain types of work to place it on a wood table mounted on wheels which can be moved rapidly about the shop, at the same time keeping the machine at a convenient height from the floor. The Flexway machine is not limited to the use of tracks but can be worked directly on a lumber pile thereby saving the handling of heavy timbers.

Car Heating Devices

Several new types of thermostats have been added to the line manufactured by the Gold Car Heating & Lighting Company, Brooklyn, N. Y. In the new types for railway cars the electric parts are entirely enclosed leaving only the temperature sensitive element outside, protected by a substantial perforated metal case. Several railway types are made to care for all classes of service and the preferences of the railway engineers. These consist of the following: "standarding setting" 68 to 70 deg., no adjustment; "night and day" giving a 70 deg.

Thermostat



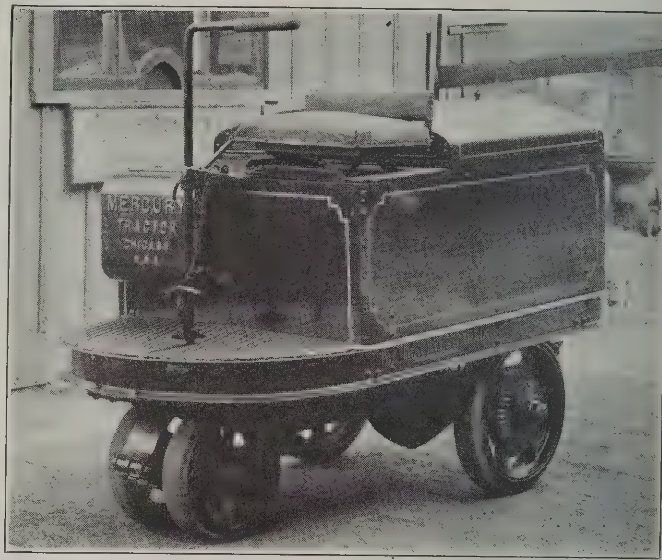
Electro-Magnetic Valve

setting at one position and 60 deg. at the other point; "service and layover" giving 70 deg. at service point and 52 deg. at layover point. These new types have been thoroughly tested and have demonstrated their practicability. The manufacturers state that they have found from tests and experience that a standard setting thermostat with a range of 68 to 70 deg. will save approximately 35 per cent of the steam in service and from 50 to 75 per cent of the steam in the yards during the layover period. The complete equipment for a passenger coach consists of one thermostat and two magnetically operated valves as shown in the illustrations.

An Improved Electric Tractor

The Mercury Manufacturing Company, Chicago, has added an improvement to its type L tractor in the form of what is known as the Twin-3 steering arrangement. Instead of a single wheel carried in a fork with no provision for spring suspension, this tractor has two front wheels connected by a short axle. The axle in turn is connected to a bracket by two semi-elliptic springs, the bracket supporting the front end of the tractor and being directly attached to the steering lever.

This tractor is said to possess the same simplicity in steering and the same short turning radius as the single

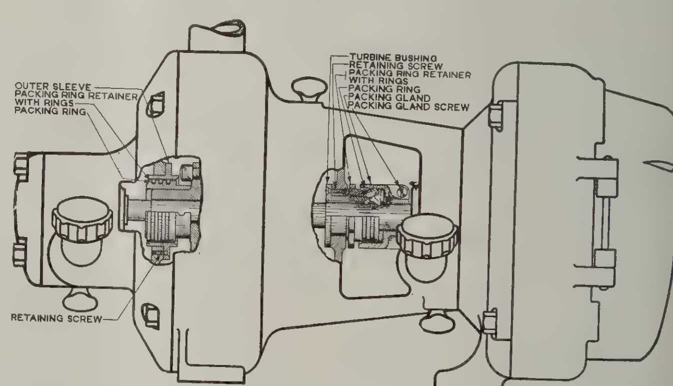


Mercury Type L Tractor with Twin-3 Steering Arrangement

front wheel machine formerly made by the Mercury Company. In addition, the important advantage of full spring suspension both front and rear is provided.

Headlight Turbine Packing

A spring ring packing for locomotive headlight turbines is being made by the Pyle-National Company, Chicago. The rings are placed in glands on each side of the turbine in practically the same manner that piston rings are used in the cylinder of a gasoline engine. The fundamental difference is that the relative motion on



Side Elevation of Headlight Set With Sections Showing Construction of Packing Glands

the glands is one of rotation instead of reciprocating motion.

Three rings are used on the turbine end and two in the generator end. The three rings are stationary, while the two on the generator end rotate with the outside collar of the gland. There is a clearance of about .05 in. between the ring grooves, so that there is practically no packing friction. The seal is effected by the water of con-

densation that finds its way into the grooves. This type of packing can be applied to all types of Pyle-National headlight turbines.

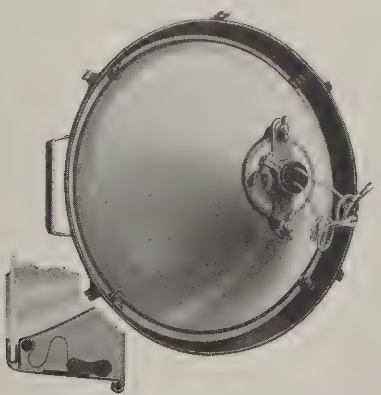
Locomotive Headlight

A locomotive headlight has been developed by the Sunbeam Electric Manufacturing Co., Evans, Ind., which employs the principle used in the manufacture of automobile headlights of having the reflecting surface and front glass contained in a separate airtight unit or goggle. The airtight unit can be removed from the headlight

Headlight With Number Door Open Showing Focusing Device and Terminal Connections

case and is held in the case by heavy spring clamps; there are no hinges. The lamp is mounted in a universal focusing device which can be removed from the airtight unit without disturbing the position of the reflector or front glass. The manner in which the reflector and front glass are held in place is shown in the sectional view.

In case it is necessary to renew the front glass, the four clamps holding the goggle are opened and the airtight unit



Rear View and Section of Air Tight Unit Showing Method of Holding Reflector

removed. The unit is laid face downward on a bench, or on some part of the locomotive, and the spring clamps shown in the detailed section are snapped open. This is done by inserting a screw driver or similar tool behind the link which holds the spring. The spring and link form a toggle which swings entirely outside of the unit when it is loosened.

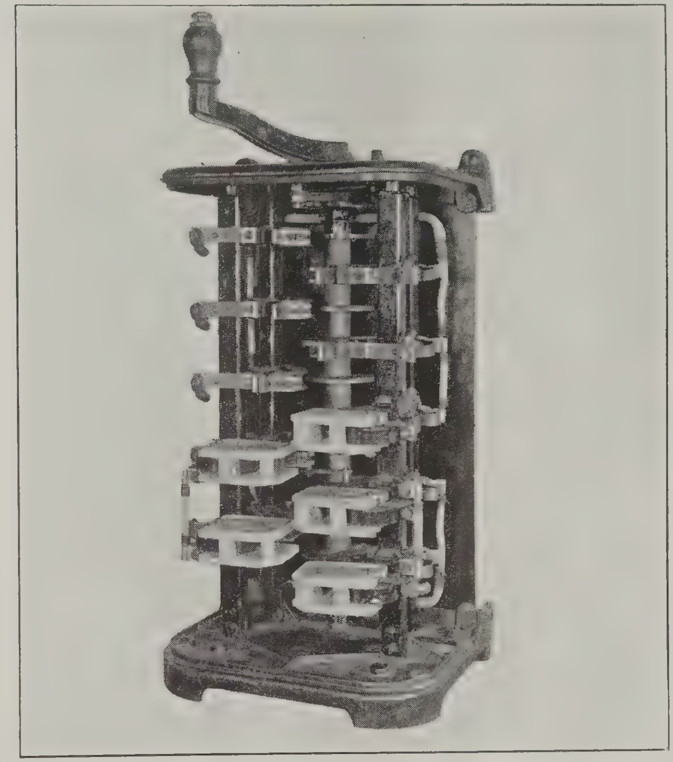
The reflector is made from heavy copper, spun to a parabolic curve and triple silver plated. It is 18 in. in diameter by 9 in. deep. The apex or filler ring which is removed with the focusing device and lamp is polished and has the same contour as the reflector, thus adding to the beam candle power of the headlight.

The case is made of 16-gage iron protected with baked automobile fender enamel. The weight is 68 lb.

Controller for Turntable Motors

The Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., is manufacturing a special form of drum controller for the wound-rotor induction motors used on turntables. The controller is designed to control two motors in cases where the required speed of turntable operation makes the use of two desirable.

The contacts are of the rolling type and are actuated



The Controller Has Rolling Contacts and Magnetic Blow-Outs

by cams. The main line carrying contacts are protected against burning by magnetic blow-outs of the same type that are used on magnetic contactors. It is claimed that this form of construction considerably lessens the burning and pitting of the contacts and that the controller is particularly suitable under conditions of hard and frequent service.

Sediment Measure for Storage Batteries

A device consisting of a long strip of wood veneer for measuring sediment in batteries has recently been introduced by the Electric Storage Battery Co., Philadelphia, Pa. The strip is inserted through the vent to the bottom of the cell. After a few moments it is withdrawn and the amount of discoloration indicates the depth of the sediment.

General News Section

The Rome Wire Company, Rome, N. Y., has taken an interest in the Atlantic Insulated Wire & Cable Company, Stamford, Conn. The latter company will continue to manufacture its brands of high grade rubber-covered wires and cables.

It is reported that the Compania Valencia de Tranvias y Ferrocarriles intends to electrify some of the railway lines it operates, in all amounting to about 45 miles. The headquarters of the company are in the Calle Orilla del Rio, Valencia.

The Okonite Company, Passaic, N. J., manufacturers of Okonite Insulated Wires and Cables, Splicing Tapes, etc., has recently opened a branch office in San Francisco, Calif., at 509 New Call Building. S. Herbert Lanyon has been appointed manager.

E. H. Young and H. E. Lavelle have been appointed exclusive eastern representatives of the Dryden Rubber Company, Chicago, Ill., with headquarters at 18 Vesey street, New York City, for the sale of Dryden "Double Wear" Friction Tape and Splicing Compound in the New England and Middle Atlantic States.

The Electric Arc Cutting & Welding Co., Newark, N. J., announces the favorable termination of patent litigation which has extended over a period of four years. The controversy concerned patents covering the construction of an alternating current arc welding transformer designed by J. C. Holslag, chief engineer of the company.

The Swiss Federal Railways have recently ordered from Swiss factories 20 electric express locomotives with a maximum speed of approximately 56 miles per hour. The locomotives will take about two years to build. During the next four to five years a total of about 100 new electric locomotives are to be built for the Federal Railways.

The Ward Leonard Electric Company, Mount Vernon, manufacturers of Vitrohm and Ribohm resistors and electrical control apparatus, announce the appointment of Joseph E. Perkins, 113 East Franklin street, Baltimore, Md., as their selling agent for Maryland, Virginia, and that part of Pennsylvania known as the Susquehanna Valley, as far north as Harrisburg.

The Chicago Union Station Company recently signed a contract with the Commonwealth Edison Company to supply 5,000 h.p. for the $60,000,000 railroad terminal under construction west of the river between West Washington and West Harrison streets. The power will be used for interior and exterior lighting, for operating elevators and other types of machinery, for signaling systems, for charging storage batteries on electric trucks and, perhaps, to some extent, for electric cooking.

The U. S. Light & Heat Corporation, of California, has been organized and incorporated as a subsidiary of U. S. Light & Heat Corporation, of Niagara Falls, N. Y., manufacturers of USL storage batteries, railroad car lighting devices and electric arc welders. A site has been leased and construction started on a new plant in Oakland, Calif. The purpose of this new plant is to handle more efficiently its growing volume of business on the Pacific Coast. It is anticipated that production will start in the new factory about October 1st.

The National Carbon Company, Inc., has established two finishing plants, one located at 237 East 41st street, New York, and the other at 560 West Congress street, Chicago. These two plants supplement the emergency department which has been maintained for some time at the Cleveland factory and they have been established to reduce the time required for handling small and other emergency requirements of carbon brushes and to give better service to customers. Both plants carry complete stocks of all leading grades of Columbia carbon, graphite and metal graphite brushes, and are prepared to furnish all sizes equipped with standard types of shunt connections or other special methods of finishing.

Westinghouse Ships Large Order to France

The Westinghouse Electric & Manufacturing Company recently shipped 32 carloads of electrical equipment—transformers and lightning arresters—to the Midi Railway (France). This material weighed over 800 tons and is part of an order totaling over $1,000,000 for this railway which is pushing its electrification program.

The lines of the Midi Railway are mostly located in the South of France north of the Pyrenees. As far back as 1906 the management of the railways commenced an exhaustive study of the electrification of this part of the system, having in mind the utilization of the water power available on the northern slopes of the Pyrenees. By 1914 four sections had been electrified with single phase current at 12,000 volts and 16.67 cycles, but all work was stopped at the outbreak of the war.

The French early in the war lost practically all their coal fields to the Germans. This more than anything emphasized the necessity of developing the water power resources of the country and electrifying the railroads wherever it could be economically done. Thus on the cessation of hostilities one of the first acts of the government was to send a technical commission abroad to study existing electrified railways.

The commission, after visiting Switzerland, Italy and America, recommended that 1,500 volts, direct current, be adopted as the standard for the electrification of all French railroads, and the Midi Railways Company, in conformity with this decision, immediately resumed the work interrupted by the war on this new basis. The sections already electrified at 12,000 volts will be changed to 1,500

volts direct current, so as to have a uniform system throughout.

Japan Buys Electric Locomotives in England

The Imperial Government Railways of Japan have placed with The English Electric Company for their Dick-Kerr Works at Preston an order for 34 complete electric locomotives of a total value of upwards of £500,000. This represents the whole requirements of locomotives up to the end of 1923 for those sections of the main line railways which the Japanese government has decided to electrify at once. The order, it is said, was obtained in the face of keen foreign competition, particularly from America.

Eight of the locomotives now ordered are for heavy express passenger service. They are of the 2-C-C-2 (*i. e.*, 4-6-6-4) type. Their weight is approximately 96 (long) tons and they are designed to haul a 415-ton train at a balancing speed of about 60 miles per hour. Each locomotive is equipped with 6 motors, each rated at 306 hp. at 500 volts, the motors being connected in two groups of three in permanent series on a trolley voltage of 1,500 volts. The control equipment is of the standard "English Electric" camshaft multiple unit type.

Of the remaining locomotives, nine are for local passenger service and 17 for heavy freight service. These 26 are all of the 4-4 type and will weigh approximately 56 tons each. They are equipped with four motors similar to those on the express passenger locomotives, but in this case the motors will be connected in two pairs in permanent series. Here, too, the control is the standard "English Electric" multiple unit type. The locomotives for local passenger service are designed to haul a 315-ton train and the freight locomotives a 600-ton train, the balancing speeds being about 55 and 40 miles per hour respectively.

$600,000 in Benefits to Employees

Almost six hundred thousand dollars was distributed last year by the Western Electric Company to 6,873 workers who were beneficiaries under the Employees' Benefit Fund.

The divisions of the Western Electric payments show that pensioners received $62,807. Sick employees were awarded $331,873; and the families of workers who died during the twelve month period were given $45,729.

In 1913 the Employees' Benefit Fund was established to provide not only for pensions but also for payments in the case of accident, sickness and death. It is interesting to compare the payments for 1921 given above with the similar payments during the first year the plan was in existence when $34,887 was paid out in pensions, $54,162 for sickness and $15,635 for death.

Electrical Engineers and Electricians

When the 1920 census was taken there were 27,077 electrical engineers engaged in the practice of their profession throughout the country. This compares with 15,278, the number of electrical engineers shown in the 1910 census. It may be stated, however, that the 1910 figures were not gathered with the same detailed care as those of 1920, a portion of the former figures being made up of estimates. In 1920 there were 212,964 electricians, as compared with 120,241 in 1910.—*Electrical World.*

Radio on Shriners' Excursion Train

Radio messages were received on an excursion train of the Southern Pacific (while it was moving at regular speed) from distances of 2,000 to 3,000 miles, according to a statement issued by that company; and it was in the day time. The train was a special carrying the Syrian Temple of Shriners from Cincinnati over the Southern Pacific. Receiving record of 2,000 miles for radiophone was established, and a 3,000 mile record for telegraph reception. Aerials were strung 8 inches above the roof of one of the cars and were 160 ft. in total length. A rail ground was used. The receiving equipment included honeycomb coils and a two-step-audio-frequency amplifier. The train left Cincinnati in radio touch with both coasts. At Denver, music programs were heard from the radio stations at Pittsburgh and Chicago. At Colorado Springs the Cincinnati station was heard. The long distance record was made at Santa Barbara when the radio, while the train was in motion, picked up the United States Government station NSS at Annapolis, 3,000 miles away. This is claimed to be a record for daylight reception under any conditions.

Overhead Wire Crossings

The American Engineering Standards' Committee, by letter ballot, has approved the National Electrical Safety Code of the Bureau of Standards which covers the generation, distribution and utilization of electricity for power, light and communication.

In making public this decision, the Standards' Committee announces that there is now in process of formation a thoroughly representative sectional committee to consider any revisions of Part 2 of this Code, "Rules for the Installation and Maintenance of Overhead and Underground Electrical Supply and Signal Lines," which may be deemed necessary by any of the interested parties. There are also being organized three sub-committees to take up the unification of crossing specifications under the three following heads:

Signal lines crossing railways
Power lines crossing railways
Power lines crossing signal lines

These committees are being organized in conformity with the action of the recent conference (March 2nd) on the standardization of crossing specifications at which there were present representatives of 14 national, engineering, utility and industrial associations, four departments of the federal government, various state commissions of Connecticut, Iowa, Minnesota, New York, as well as representatives of the telephone, telegraph and cable companies.

Electric Power for the Pennsylvania

Electric energy, purchased from the Philadelphia Electric Company, will be used for the operation of the West Jersey and Seashore Electric line which runs between Camden and Atlantic City. An agreement has been reached between the Pennsylvania, which controls the West Jersey, with the Electric Company for the necessary work of building a connecting line. The power now used is generated by the railroad at its Westville plant. It has not been decided whether this plant will

be abandoned or maintained for auxiliary and emergency purposes.

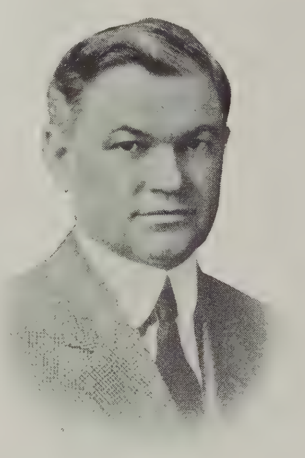
To obtain power from the new source, the Pennsylvania will run a line across its Delaware river bridge and connect with the West Jersey at Westville. The power line after reaching Delair, N. J., across the river from Bridesburg, will follow the old Haddonfield-Westville cut-off to Westville.

Personals

H. D. Shute, vice president and general sales manager of the Westinghouse Electric & Manufacturing Co., has been elected a member of the board of directors of the Standard Underground Cable Co., Pittsburgh, Pa.

A. B. Saurman, general sales manager of the Standard Underground Cable Co., Pittsburgh, Pa., has been elected a vice president of the company and will combine the duties of his new office with those of general manager of sales.

Ernest Lunn, chief electrician of the Pullman Company, has been elected a manager of the American Institute of Electrical Engineers. Mr. Lunn was born in Greenville, Mich., in 1874. He graduated from the University of Michigan in 1899 as electrical engineer and was then employed for three years by the Detroit Edison Company. In 1902 he associated himself with the Commonwealth Edison Company as a storage battery engineer and served in this position for 12 years, with the exception of a seven months' period in 1910, when he was in the service of the Firestone Tire & Rubber Co. of Akron, Ohio. For a period of time Mr. Lunn acted as consulting engineer for the Walker Vehicle Company of Chicago, and from 1903 to 1914 he was successively secretary-treasurer, vice president and general manager and president of that company. In 1914 he accepted the position of chief electrician of the Pullman Company, which he now holds. Mr. Lunn is also a vice president of the Association of Railway Electrical Engineers.



Ernest Lunn

F. W. Carter, assistant manager of the heavy traction division, railway department, of the Westinghouse Electric & Manufacturing Company, has resigned to become president of the Louisville Frog & Switch Company, Louisville, Ky.

H. A. Shepard, superintendent of telegraph of the New York, New Haven & Hartford with headquarters at New Haven, Conn., has been appointed superintendent of electric transmission and communication with the same headquarters and the position of superintendent of telegraph has been abolished. The jurisdiction of Mr. Shepard's new office will include all lines of electric communication and transmission on the system, including the electrified territory between New York and New Heaven. Charles S. Dow has been appointed superintendent of communication with headquarters at New Haven.

S. H. Lanyon has been appointed manager of the recently opened San Francisco branch office of the Okonite Company, Passaic, N. J., manufacturers of insulated wires and cables, splicing tapes, etc. His office is located at 509 New Call building.

J. H. Rodger, western manager of the Safety Car Heating & Lighting Company, with headquarters at Chicago, has been promoted to vice-president with the same headquarters, in charge of that company's western business. Mr. Rodger entered the railway supply business in 1899, in the service of the Standard Coupler Company, which company he left in 1905 to become assistant to the president of the Monarch Machine Company, New York. In 1911, he became a sales agent of the Safety Car Heating & Lighting Company in its Chicago offices. He was promoted to western manager of that company in 1919, which position he was holding at the time of his recent promotion.

J. H. Rodger

Trade Publications

Roller-Smith Co., New York, has recently issued its bulletin No. 560 describing and illustrating the new type of enclosed circuit breaker which it has recently placed on the market.

Train Lighting is the name of a 46-page, 5½ in. by 9 in., cloth bound book, recently issued by Rotax (Motor Accessories) Ltd., London, England, describing the Leitner system of electric car lighting. The book comprises a general description of the Leitner system as applied to English railways.

Benjamin Electric Mfg. Co., Chicago, Ill., is distributing its pocket catalog No. 23. The book measures 5 in. by 6½ in., and contains 252 pages devoted to the illustration and description of the Benjamin electrical products. It is believed that the booklet will fill a long felt want in the way of a pocket edition.

Gould Coupler Co., Electrical Department, New York City, has just published its bulletin No. A-21, illustrating and describing the Gould "Simplex" system of car lighting. The bulletin is 6 in. by 9 in. in size and contains 26 pages. Photographic reproductions of the Gould equipment, including generators, generator details, generator regulator panels and lamp regulator panels, as well as many other details of the smaller parts.

Railway Electrical Engineer

Volume 13 SEPTEMBER, 1922 No. 9

Are You Going to the Convention?

A number of those who usually attend the annual convention of the Association of Railway Electrical Engineers may feel that they cannot possibly spare the time to go this year. Labor conditions have made it necessary in some cases for electrical officers to do wiremen's work and on practically every road there are new men to break in or there are situations that require the greatest diplomacy to handle. There is also a lot of back work to make up, but do not let these conditions blind your good judgment. Is there, in the last analysis, a more profitable way for you to use your time than by taking an active part in the convention? The present situation calls for more than hard work; it calls for the best knowledge and experience. The convention offers a rare opportunity for obtaining the knowledge and learning of the experiences of men confronted with the same problems as you are on other roads.

Looked at from the viewpoint of the Association, there never was a time when your active co-operation was more needed. The A. R. E. E. is steadily receiving greater recognition and this in turn reacts on the status of the electrical man on the railroad. Other organizations, which have curtailed their activities and suspended conventions during the past few years, have suffered a considerable amount of disorganization. This has not been the case with the A. R. E. E., and it indicates that there are good opportunities for the Association and its members. No organization can stand still and this convention should mark another step in the progress of the Association.

The March of Progress

The latest types of steam locomotives, particularly those for freight service, are big units. They are as large as it is practical to build them without going into the Mallet type and they are equipped with almost every conceivable sort of a device to make them more powerful and more economical in operation. These devices include superheaters, feedwater heaters, brick arches, a separate engine geared to the trailing truck or to a tender truck, etc. The great size of the locomotives in turn necessitates the use of automatic stokers, power-operated shakers and power-operated reverse gears.

All of these devices facilitate the operation and greatly improve the performance of the locomotive as compared with a locomotive not so equipped. Properly maintained and used, superheaters and feedwater heaters increase the efficiency and capacity of a locomotive. A mechanical stoker increases the capacity, but is not usually as efficient as good hand firing. An extra pair of cylinders geared to the trailing axle increases the drawbar pull at starting and at low speeds.

The builders point out the fact that great power is developed and an up-to-date steam locomotive with a reduced weight per horse power; approximately 3,000 hp. can be developed by a locomotive weighing with the tender about 270 tons. The tendency is toward greater starting effort and greater sustained power from a single unit with the highest efficiency that is consistent with these requirements.

In other words, it might be said that the tendency is toward the characteristics of electric locomotives that have been in service for years. There are electric locomotives in operation of the above weight which develop a maximum horsepower of 6,700 with a correspondingly high sustained horsepower. In fuel economy the electrics showed a saving of 28 per cent as compared with Mallet locomotives in the same service. Maintenance costs of these particular electric locomotives at first were high, but through the knowledge gained by several years experience, these costs have been greatly reduced. Accessories, such as used on the steam locomotives tend to increase maintenance costs.

The shopmen's strike has emphasized the fact that electric locomotive performance does not depreciate rapidly due to temporary lack of care. Electrification must be considered a major improvement necessitating large capital expenditure, but as straws show which way the wind blows so do these facts show that there is an ever increasing demand for service such as can be supplied by electric motive power.

Study the Welding Art

Electric arc welding has already been the means of saving the railroads many thousands of dollars both in the repair of broken equipment and in the reclamation of worn parts which, in the past, have been thrown onto the scrap pile. There are certain to be many more applications for welding as the practice comes into more general use but it will prove a very great mistake if arc welding is applied indiscriminately. Welding is unquestionably a great money saver and yet it has its limitations. When an attempt is

made to exceed these limitations by welding parts or materials which from the nature of their functions cannot give satisfactory service, the art is not only retarded but is given a decided set back.

It should be the aim of every welding supervisor to study carefully what *is* possible of accomplishment and what cannot be undertaken with the certainty of success. The different jobs that have been welded total up to an astounding figure and cover an exceedingly wide scope. A welding supervisor must have a wealth of experience to be able to tell in advance what can be expected of any particular job that comes to his attention for the first time. If his experience has taught him that a certain weld will not stand up in the strenuous work which the part must perform, it is a great mistake to make such a weld, for not only does the work fail to give satisfaction and in some instances perhaps prove dangerous, but it invariably puts the welding art in bad repute and hampers its legitimate progress.

The attempt to weld something which should not be welded, however, is not the only way in which reflections may be cast upon the art. It is also of greatest importance to know what kind of welding materials and what method of procedure to use.

Another thing which plays a great part in successful arc welding is the right preparation of the work. Careless preparation and dirty material can only result in poorly executed work.

These and other important points are clearly brought out in an article on this subject which appears on page 283 of this issue. Study the results of others. Be warned by their failures and strive to emulate their successes. There is no royal road to electric arc welding and he who leads in the art will be he who through diligent search and study has become a master of the numerous factors that enter into the accomplishments of a perfect weld.

Where Electrification Applies

Hauling a train over a four and one-half per cent grade is a feat in railroad operation that is economically possible in only one way and that is by the use of electric power. Of course, we are referring to operation on ordinary rails by adhesion and not to the use of rack rails. Running trains over such ascending grades falls at once outside the scope of steam locomotive practice and leaves the field wholly to electric operation, which alone is able to meet the severe conditions imposed by rugged, mountainous country.

The supremacy of the electric locomotive for mountain operation can be perhaps better appreciated by more intimate knowledge of specific applications such as will be found in an article on page 279 of this issue. Here is described and illustrated the mountainous country of the canton of Grisons, Switzerland, where the Rhaetian railway winds its way up the rocky sides to a height of nearly 6,000 ft. above the sea level. Not only is the electric locomotive indispensable in traversing the heavy grades which prevail over almost the entire length of the Rhaetian railway, but the desirable factor of smokeless operation is of greatest importance on a line which abounds with tunnels. There are on the Rhaetian railway 39 tunnels, the total length of which amounts to 33,350 ft. There is probably no other country in the world where so many tunnels are needed or where so many heavy grades are encountered as in Switzerland; and, incidentally, there are few countries that are better supplied with water power. These factors, together with the high price of coal, point out unmistakably the exit of the steam locomotive from Swiss territory.

There are no roads in America where the conditions are on a par with those of Switzerland but there are mountain grades and long tunnels which resemble those described. Economically speaking, some of these points should be electrified immediately—eventually they will be. The inherent characteristics of the electric locomotive plus the economic advantages from an operating standpoint form a combination that is steadily becoming a more potent factor in the transportation industry.

The cost of electrification is high, but in the light of the many desirable features which follow its adoption, it is not always prohibitive and roads which early recognize this fact are going to be in position to reap the financial rewards that will ultimately result from less extensive operation.

New Books

Railway Electric Traction, by F. W. Carter, 6 by 9 in., 412 pages, 204 illustrations, including 13 insert plates. Bound in cloth. Published by Longmans, Green & Co., Fourth Ave. and 30th St., New York. Price $8.50.

The book was written in England but the text is in no way confined to English methods as all of the principal installations of heavy electric traction are discussed. There are ten chapters and an appendix. The first chapter is introductory and deals with the reasons for adopting electric traction and the relative merits of direct and alternating current systems. The author declares himself in favor of the direct current system. "The Locomotive" is the title of chapter II, which is the longest chapter in the book. The design of locomotive with relation to the effect on track is discussed extensively. Chapter III bears the title "Railway Motors" and is quite exhaustive. Motor control is presented in considerable detail in chapter IV. Chapter V deals with the distribution system, including several types of third rail and overhead construction. Methods for determining sag, tension, etc., are included. Chapter VI deals chiefly with power equipment. Systems of electrification are outlined in chapter VII. Chapters VIII and IX deal with mechanics and include such subjects as train resistance, methods for calculating speed, time, and distance, energy requirements, etc. Power Supply is the subject of chapter X which deals broadly with sub-stations and power plants. The appendix consists of a table of locomotive statistics which includes most of the principal electric traction systems in the United States and Europe and gives data concerning the general characteristics of the various locomotives used.

Hand Book of the Electric Power Club, 4 by 6½ in., 284 pages. Paper binding. Published by the Electric Power Club, Kirby Building, Cleveland. Price 50 cents.

The Electric Power Club hand-book covers standardization in the electric motors, motor pulleys, generators, transformers, electric tools, mining and industrial locomotives, control equipment, power switchboards and switching equipment manufactured in this country. The handbook contains definitions, symbols, general engineering and recommendations. Single copies will be given without charge to consulting engineers, electric light and power companies, contractors and educators.

Ardez, an Interesting Spot on the New Electric Railway

Rhætian Railway Completes Electrification

Operation on Swiss Scenic Road With Many Tunnels and Heavy Grades Made Possible Only by Electric Power

THE Rhætian Railway, which in conjunction with some smaller private lines, operates a network comprising 248 miles in the very mountainous canton of the Grisons, Switzerland, officially celebrated, on May 17th last, the completion of the electrification of those sections which were originally built for steam traction.

The history of this scenic road dates back to the year 1888, to a period when the enormous value of the available hydraulic resources had not yet been realized. At that time and during the following year the 20¼ mile section from Landquart to Klosters was constructed, and at once regarded as the first instalment of an Alpine railway to Italy. On account of the cost, the standard gage was out of the question, but as a narrow gage line, with one meter (39.37 inch) track, it is one of the most important in the whole of Switzerland. The line along its entire course has been built on the ordinary adhesive principle, without recourse to the plan, which so obviously suggests itself and has been used on other similar lines, of introducing an auxiliary rackrail in the centre.

Inasmuch as the canton of the Grisons contains not less than 150 different valleys, the Rhætian Railway, branches out in various directions to different important tourist centres.

Landquart-Davos

The connecting link between Landquart, a station on the Swiss Federal Railroads System and Davos, the world-famous health and sport centre, has a length of 31 miles. Its original cost, including the subsidies which were contributed by the communes, partly in cash and partly by furnishing the necessary timber free of charge, amounted in round figures to some $1,700,000 or $47,032 per mile.

The steepest gradient on this section amounts to 4.5 per cent, the minimum radius of the opening track being 328 feet. The starting point, Landquart station, has an altitude of 1719 feet above sea level; Wolfgang station, the highest point, is 5,370 feet above sea level; and Davos, the terminus, is 5,064 feet. Between Landquart and Küblis the track passes along the bed of the valley, where its steepest gradient is 3.5 per cent and from there on 4.5 per cent. Above Klosters a loop-tunnel 1,098 feet long was necessary in order to grapple with the ascent. Altogether there are three tunnels comprising a total length of 2,128 feet.

Davos-Filisur

In order to attain during the course of the extent of this line, which in round numbers is only 12 miles long, the considerable difference in altitude between Davos (5,164 feet) and Filisur (3,555 feet), the minimum grade could not be made less than 3.5 per cent. The minimum radius of the curves amounts to 395 feet.

This particular section includes 15 tunnels with a collective length of 13,800 feet. Its outstanding feature, from an engineering point of view, is the Wiesen Viaduct, 690 feet long, with 6 openings, each 66 feet wide, and a central parabolic arch of 180 feet span which strides across the Landwasser valley at a height of 289 feet. Built of squared stone, this enormous arch stretches lightly and almost gracefully across the yawning gorge. The structure fits in so well with the natural surroundings, which have supplied its material, as to become part of them, and the swift passage over the bridge leaves little other impression than that of the tremendous height.

The cost of construction amounted to $1,088,000 or $92,365 per mile. The substructure alone cost $768,000 or $65,195 per mile.

Landquart-Thusis via Chur-Reichenau

Concessions originally granted to others for the narrow-gage railway lines from Landquart to Chur and from Chur to Thusis were acquired by the Rhætian Railway Company in 1894. Construction was started immediately and the work was carried out so rapidly

that the entire line from Landquart to Thusis could be opened for traffic by the summer of 1896.

This line is 25.6 miles in length. The minimum radius here is also 328 feet, as on the line from Landquart to Davos. The steepest gradient is not more than 2.5 per cent. The total cost of this particular section amounted to $1,400,000 or about $54,839 per mile.

Thusis-St. Moritz (known as the Albula line)

This section is 38.34 miles long. The steepest gradient between Thusis and Filisur is 2.5 per cent; between Filisur and Bevers 3.5 per cent and between Bevers and St. Moritz 2 per cent.

The altitude of the railway above sea level at Thusis is 2,302 feet; at Filisur 3,555 feet; at Bergün 4,524 feet; at Preda 5,892 feet; at Spinas 5,890 feet; at Bevers 5,633 feet; at Samaden 5,620 feet; and at St. Moritz 5,844 feet. The highest point, 5,998 feet, is in the Albula tunnel between Preda and Spinas.

The Rhaetian Railway in the Interesting District of Thusis, with the Ruins of the Castle of Campi in the Background

The ordinary radius of the curves on this line is 395 feet; only in very few cases has it fallen as low as 328 feet.

The nature of the mountains traversed is such that the number and length of the tunnels and viaducts on this particular section are abnormally great. Besides the Albula tunnel, there are 38 smaller tunnels, the total length of which is 33,350 feet, of which all but 7,892 feet had to be lined with masonry.

The Albula Tunnel (19,242 feet in length)

The Albula tunnel is the longest ever built on a narrow-gage railway. Its construction was attended with enormous difficulties, the greatest of which was the sudden tapping of powerful springs of cold water in soft stone and dolomite sand. The efforts to overcome these difficulties were extremely toilsome and caused an interruption of fifteen months in the progress of the work on the northern side.

After these dangerous places had been successfully overcome, it was possible to proceed with the machine-boring in the granite, three of Brandt's rock-drills being kept at work simultaneously at either end. An average daily advance of 190.3 feet was made and by April, 1902, the progress with the boring on the northern side was gradually increased to 239 feet, which rate as a month's average through solid rock had probably never been reached before.

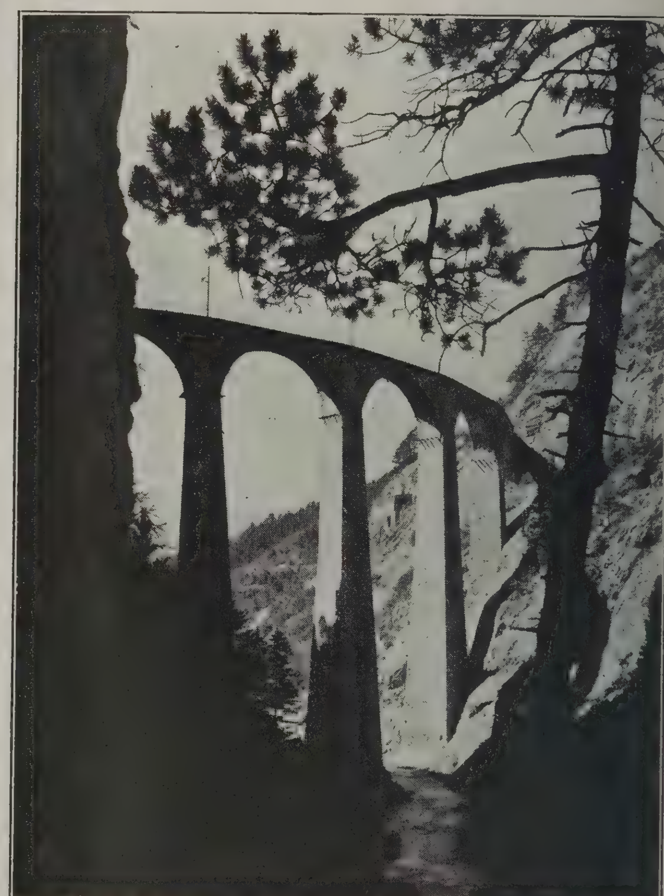
The work had been commenced in October, 1898, and on May 29, 1902, the tunnel was pierced. The greatest feat was accomplished in the year 1902, when fully half of the tunnel, a length of nearly 9,840 feet, was finished.

Cost of the Albula Railway

The cost of the Albula Railway amounted to $4,600,000 or $119,355 per mile. The rolling-stock on the line cost $400,000 or $10,322 per mile.

The substructure alone cost, without the Albula Tunnel $2,200,000, or $57,097 per mile, and the Albula Tunnel itself cost $1,414,000.

As the Wiesen Viaduct is an outstanding feature on the line from Davos to Filisur, so is the Landwasser Viaduct between Alvaneu and Filisur on the Thusis-Filisur Section of the Albula Railway a marvel of engineering skill. This viaduct has a very striking effect on account of its slender, but powerful stone piers and its formidable height of 213 feet. It is 426 feet long and has 6 openings each of which is 66 feet wide. The radius of its curve measures 328 feet. As a compensation the gradient on the Landwasser viaduct is reduced from 2.5 per cent to 2 per cent. Above the wild Landwasser gorge, one sees to the left the houses of the hamlet of Jennisberg and above it, in the background, the Leidbachhorn between the Landwasser and Sertig valleys of the Davos district. The Albula valley, which the line follows, makes a bend here and mounts toward the southeast. Behind, a



The Imposing Landwasser Viaduct on the Albula Line Section. This Structure Is 213 Feet High and 426 Feet Long

glimpse is again caught of Alvaneu and Mons and then the train enters Filisur (villa sura—the upper village).

Beyond Filisur the actual mountain stage of the Albula Railway begins. The gradient, which hitherto has never exceeded 2.5 per cent now increases to 3.5 per cent and this is maintained, with some slight exceptions, till Preda, at the mouth of the Albula tunnel, is reached. As this gradient was in itself insufficient to enable the altitude of Bergün to be reached in a direct line, numerous artificial developments, such as loops and spiral tunnels, had to be introduced above Filisur.

The difference in altitude between Bergün and Preda

An Interesting Section of the Rhaetian Railway Between Davos and Filisur

is 1,368 feet—and necessitated a track length of 7 4-5 miles, with a gradient of 3.5 per cent, whereas the length of the valley is only 4 miles.

The continuous change in the direction of the journey makes it very difficult for one traveling on this line for the first time to find his bearings. However, the village of Latsch above Bergün affords a splendid means of determining one's position; soon after leaving Bergün, it is visible above to the left and then again alternately to the right and left, until at last, before the Zuondra spiral tunnel is reached, it disappears. The railway at this point is already higher than the village, which during the journey seems slowly to sink deeper and deeper, until Muot is reached. Bergün too is visible again and again.

The little hamlet of Preda which has only been inhabited all the year round since the opening of the railway lies at the entrance of the Albula Tunnel. On leaving the tunnel at Spinas, the line enters the Bevers Valley, a side valley of the Upper Engadine, following the Beverinbach in a fairly straight line with a maximum fall of 3.2 per cent.

Ilanz-Disentis

While the 12-mile section Reichenau-Ilanz was constructed during the period when the Landquart-Chur-Reichenau-Thusis line was built, connection with Disentis, a leading resort in the Grisons Oberland, was only completed for July, 1912. This line which measures 18.63 miles did not present the same technical difficulties as some of the previously described sections; it is, however, a route of great scenic charm and will gain greater importance yet when the Furka railway, which is now operated between Brig in the Rhone Valley and Gletsch, the Rhone glacier, is finally extended to Disentis, thus providing a direct railroad route between the two important Swiss cantons, Valais and Grisons. However, since the swift and commodious post-autobuses have been introduced on the majority of the Swiss alpine passes, travel from Disentis over the Oberalp and Fruka Passes has increased at a truly astonishing rate.

Bevers-Schuls

This latest 31.05 mile extension of the Rhætian Railway has been operated by electricity from the beginning and was opened for traffic in 1913. From Bevers 5,620 feet above sea level it descends with the river Inn (a tributary of the Donau), which has its origin near Maloja, 5,940 feet above the sea level, at the topmost point of the Upper Engadine, down to Schuls-Tarasp-Vulpera, a cluster of world-famous spas, varying in altitude from 4,080 feet to 3,946 feet and 4,183 feet respectively.

As in the case of the Ilanz-Disentis line, where the

View on the Famous Albula Section of the Rhaetian Railway

Rusein bridge near Disentis with 4 openings of 65.62 feet each is the only outstanding technical feature, so was the construction of the Bevers-Schuls portion a comparatively easy matter. The Inn viaduct near Cinuskel, 154 feet wide, and the Püzza viaduct near Fetan, 439.65 feet long with four arches measuring 88.59 feet each, are the most noteworthy portions of this section from a technical point of view; the entire line, however, offers enchanting vistas of glorious scenery and quaint Engadine villages.

Calculations indicate that the 172 mile net of now

entirely electrified lines belonging directly to the Rhætian Railway Company cost almost 120 million Swiss francs, $24,000,000, consequently about $200 per head of the population of the canton.

Power stations at Bevers, Küblis (near Klosters) and Thusis supply the necessary energy.

Electric Furnace Replaces Oil Equipment

THE Griffin Wheel Corporation, of Chicago, Ill., is converting its brass foundry at South Tacoma, Wash., into an electric furnace foundry, by installing electric melting furnace equipment.

Railway and car brasses, running high in lead, are melted in this foundry. Previous to the electric installation oil furnaces have been used.

The electric furnace installation which has just gone into operation at this plant is rated at 75 kw. in electrical capacity, holds 800 to 1,000 lb. of metal and has a minimum production capacity of 500 lb. per hour.

Electric furnaces of the type installed by the Griffin Wheel Corporation are known as "Baily" Resistance Type Furnaces and are built by the Electric Furnace Company at Salem, Ohio. They are designed upon a very simple and practical electrical principle. A special transformer is supplied which takes energy at any primary voltage up to 22,000 volts and steps it down to the relatively low voltages required by the furnace by means of nine separate voltage taps brought out on the secondary side. These control taps are connected to a selective oil break switch. A very close control is possible over the power supply by closing this switch into any one of the nine positions, thus any desired furnace temperature may easily be attained and maintained.

The current passes from the switch into the furnace through two carbon blocks which are embedded in a circular trough of carborundum—the latter being mounted on radial piers within the furnace chamber. This trough is packed with granular carbon, which is brought to incandescency by the passage of the current through it. The whole chamber is sealed so that no oxides or gases can come in contact with the molten metal, thus assuring castings free from porosity and gas occlusions. This results in the percentage of rejections being brought to a minimum and reduces the metal loss to less than one per cent. There are no complicated parts anywhere about the furnace and the whole equipment is most simple and economical. After the switch is closed and the metal charged into the furnace no further attention from the operator is required until the charge is poured. The furnace tilts by means of a convenient hand wheel and the metal flows down a grooved spout into the pot without necessitating the opening of the charging door at all.

Putting Metal Into the Electric Furnace

Rainfall is so rare on the Rock of Gibraltar that the inhabitants have to store the rain in reservoirs during the wet season.

Four-Wheel Drive Rail Motor Car and Trailer on New Orleans & Lower Coast

The New Orleans & Lower Coast has had in operation since November 3, 1920, a motor coach, the chassis of which was furnished by the Four-Wheel Auto Company, Clintonville, Wis., and the body built at the railroad shops. An increase in traffic recently made it necessary to add a trailer. The motor car seats 30 passengers, while the trailer has seats for 22 and accommodations for baggage, mail and toilet. Since the service was started, the motor car has made one round trip every day except Sundays, between Algiers and Buras, which are 60 miles apart.

Electric Arc Welding in Locomotive Work*

Care in Preparing for the Weld Is Most Important for Successful Work and for the Good Reputation of the Art

By C. W. Roberts

Welding Foreman, Pennsylvania Railroad, Columbus, Ohio

ELECTRIC arc welding is of comparatively recent origin, and as we believe in the American Welding Society is just in its infancy. As in everything else, we no sooner discover or perfect a new method, but what it is immediately subjected to abuse.

Electric arc welding is now indispensable in a large number of our industries and will continue to increase in importance and efficiency. It will increase more rapidly if we strive to eliminate the abuse that is brought about by carelessness, ignorance and lack of interest.

There is considerable discussion and differences of opinions as to just what should or should not be welded.

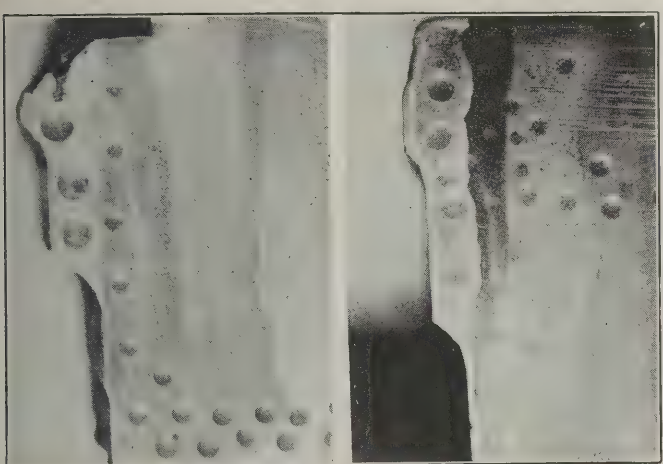


Fig. 1 Fig. 2

Fig. 1—Cross Section of Crosshead Guide Built Up with Carbon Arc
Fig. 2—Similar Section Built Up with Metallic Arc

It is undoubtedly true that in all processes of autogenous welding that an intense local heating is unavoidable and that in the cooling there is liable to be a certain amount of locked up stresses in some jobs. Are these locked up stresses great enough and so menacing as to warrant the discontinuance of a large amount of our welding?

It is undoubtedly true that different locomotive parts that have been electrically welded have since failed, some after long and very hard service. Similar parts that have never been welded have failed also. I refer to such parts as crossheads, pistons, rocker arms, valve yokes, guides, link motion parts and similar machinery.

Let us investigate these failures thoroughly and without prejudice or partiality, and find out if the failure was caused from locked up stresses, fatigued metals, faulty or inferior castings and forgings, or by the inefficient and careless welder or supervisor.

In electric arc welding, as in everything else, there are limitations, and an efficient supervisor will know these limitations and will refuse to go beyond them, as he knows such work only leads to the condemning of the entire practice of electric arc welding. It, therefore, follows that your supervisor must have co-operation.

The commonest cause of failures are the inefficient and indifferent workmen and the little heed taken to have a perfectly clean and properly prepared job; although suitable equipment and proper electrodes for the work at hand should not be overlooked. Your finished result, I might say, is 90 per cent operator, 10 per cent equipment and materials, while preparation and operation are about a 50-50 break. You cannot get thoroughly satisfactory results no matter how good your welder's ability may be, if the work is not first properly prepared.

Our men on this work with which I am most familiar are welders; they are able and do do all kinds of autogenous welding. They are men who started at the bottom and were retained because of their ability and interest in welding. They have become proficient in all phases of electric arc welding and oxy-acetylene welding. They

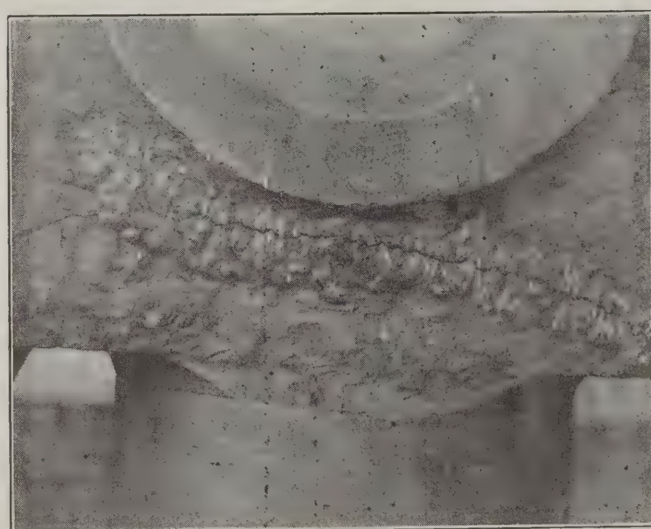


Fig. 3—An Example of Work Which Causes Welding To Be Condemned

are welding operators, which is and should be recognized as a trade in itself; a trade in which a man should receive instructions and serve an apprenticeship, just as a boilermaker, blacksmith, machinist or any other craftsman. Just because a man is any one of these craftsmen, is far from being an intelligent or rational reason why that man should be called a welder, given the welder's rate of pay and set to work. This is one of the chief reasons why today we have so much inferior work for which electric arc welding is being condemned. It is the incapable operator and not the method that should be condemned.

Your craftsman may become a welding operator after

*An abstract of a paper presented at the April, 1922, meeting of Pittsburgh Section, American Welding Society.

he has received instructions and served his apprenticeship (if he has the ability), and he may be able to master all phases of electric arc welding and oxy-acetylene welding, such as firebox, boiler, machinery and equipment work, in the roundhouse, back shop, yard or road. However, he will not acquire that ability in its entirety in six days, six weeks, or six months. It takes perseverance, endeavor, and actual experience, and lots of it, to make a thoroughly reliable welding operator. They are not made over night.

We employ both the carbon and metallic arc processes and find a very large and ever-increasing field for both methods. The illustrations will give some idea of a few of our different operations.

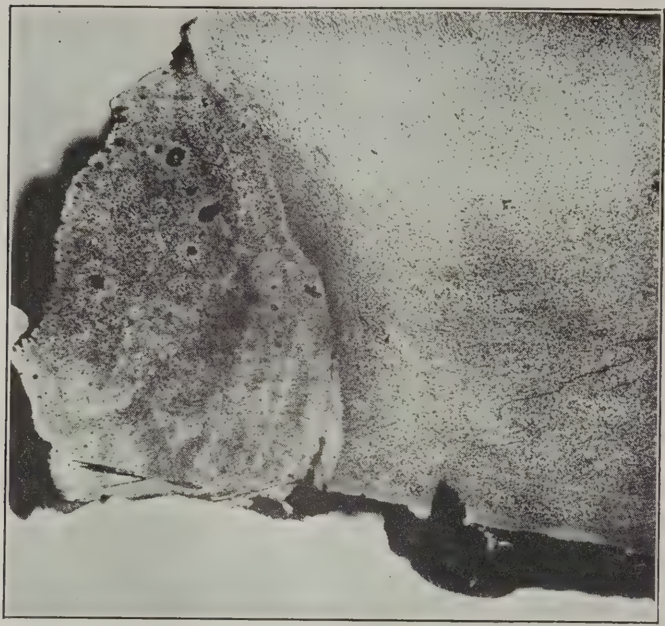


Fig. 4—An Example of Work Done Upon An Improperly V'd Out Casting

Fig. 1 shows a cross section of a crosshead guide which was built up so as to finish ⅜ in. higher than the worn surface. This was done by making two runs of metal with the carbon arc. You will note the very uniform change of structure and heat penetration caused by the two runs of the arc in the original metal adjacent to the weld.

The scleroscopic test for hardness showed the welded metal to be much softer than the original steel which has a carbon content of about .55, while the filler rod conformed to the American Welding Society's specifications and contained .18 carbon. I have been pretty well convinced by these and other tests that an electrode should be used in most cases with a chemical analysis that will give you in the weld metal an analysis similar to that of the original metal.

A similar cross section is shown in Fig. 2. This was welded by the metallic arc process. Note the uneven line of penetration and the more pronounced and varied change in structure of the original steel. I might add for the information of those unfamiliar with the two methods that the cost of labor per inch is less than four (4) mills in the case of the carbon arc as against eighteen (18) mills in the metallic arc, or your metallic arc in this case costs four and one-half (4½) times as much as the carbon. If only ¼ in. of finished metal is desired the difference will be only about 3 to 1.

With the carbon arc we use a ⅝ in. rod and in the metallic arc a 3/16 in. or ¼ in. rod.

Fig. 3 shows how easily electric arc welding can be and is condemned. It shows a crosshead that came into our roundhouse after its run. You can see just what I found. You will notice that in the repairing of this job that the fracture was not followed to its end, but had been V'd out and welded where no fracture existed. About six months later I traced this case down and found that an engine house foreman had ordered the crack partly V'd out, welded up and sent out. It got as far as the first inspection point after it left the point where the repairs were made. I then took the acetylene cutting torch and cut out a piece one inch wide each side of the weld. Fig. 4 will show you what I found. You will note that the fracture had been V'd out just 1/3 the thickness of the casting, welded over and sent out. It is simply courting certain failure to put out such work—you must V out the crack entirely and clear through. If your original casting broke in service what do you expect out of a repair such as this? The original casting at this point when cut with the acetylene showed a very porous and badly oxidized metal. Even had the original crack been V'd out properly and welded carefully it would have failed, as you will note a small crack which extended from the inside, where it would not have been found. Here then, would have been an opportunity to condemn electric arc welding and failure might be attributed to locked up stresses. I might add that this crosshead had seen considerable service, as the crosshead pin hole had been filled in by the metallic arc process and rebored and this is never done until after numerous machinings have increased the diameter of the hole to the limit.

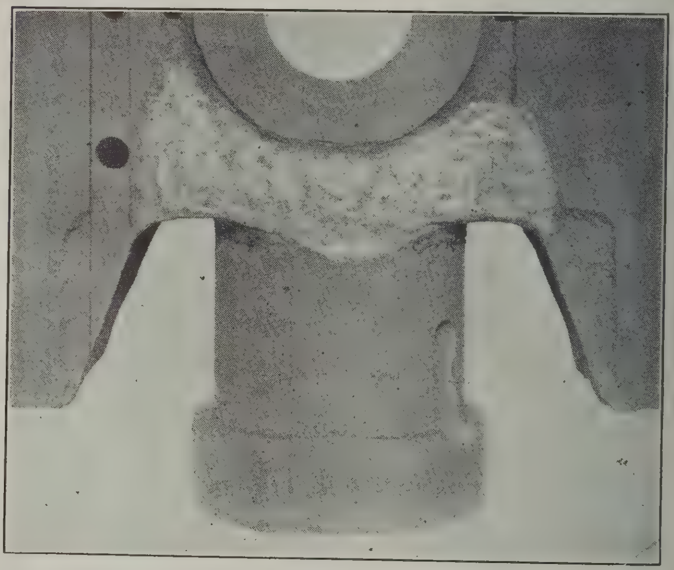


Fig. 5—The Same Crosshead as Shown in Fig. 3 After being Welded with the Carbon Arc Process

The same crosshead after being welded by the carbon arc process is seen in Fig. 5.

During the war when supplies were scarce, most any material that could be obtained was used in electric arc welding and I believe from the appearance of some of our work today, this condition is still permitted to exist at

some places. This should not be tolerated, for proper and suitable electrodes and materials go a long way toward producing satisfactory results.

The truth of this statement in the matter of suitable electrodes for carbon arc welding is shown in Fig. 6. Electrodes one and two are ⅝ in. in diameter; both were placed in the holder jaw to extend through four inches;

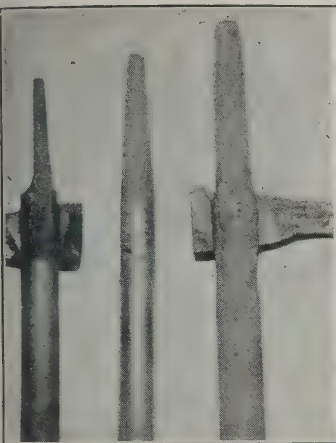


Fig. 6

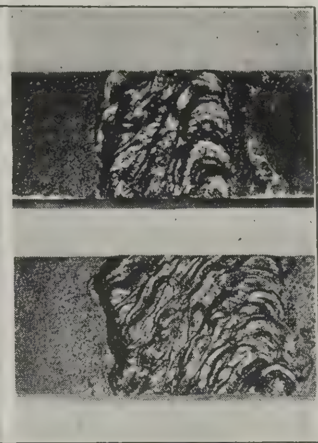


Fig. 7

Fig. 6—How Various Electrodes Burn Away in Service
Fig. 7—View of Fire Side of Two Firebox Side Sheet Seam Welds

both were used constantly for 20 minutes under same voltage, amperage, and other conditions. No. 1 is a carbon and No. 2 a graphite electrode. The carbon decreased in length 1⅞ in. and in diameter to ¼ in. and burnt off the holder jaw as you will note, while No. 2, which is graphite, decreased in length 1⅛ in. with a gradual taper and the holder jaw was not affected in the least. No. 3

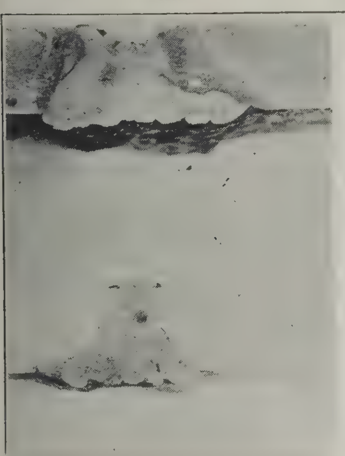


Fig. 8

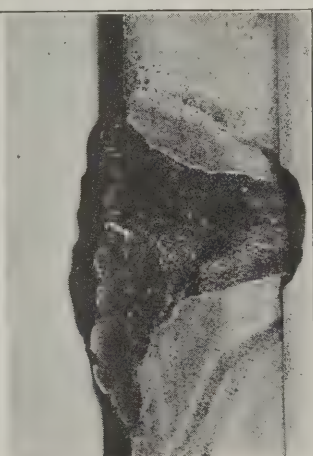


Fig. 9

Fig. 8—Cross Section of Two Welds Showing the Results of Improperly Prepared Work (above) and Correctly Prepared Work (below)

Fig. 9—An Enlarged View of Electrically Welded Side Sheet Seams with 45 Degree Bevel and a ⅛-In. Opening

is a ¾ carbon, somewhat denser than No. 1 carbon. This lasted just 15 minutes (under same conditions as Nos. 1 and 2), when it dropped through the holder jaw having decreased ½ in. in length, also in diameter and burned out the jaws as you will note. A graphite electrode will carry your current in a straight even flowing arc with practically no whipping or spluttering of the flame, while a carbon electrode is unstable, will whip and twist and give a constant spluttering and squealing arc. Graphite electrodes keep your welder operators amiable and contented and pay big dividends in the amount of work accomplished and the amount of electrodes and holder jaws saved, to say nothing of the superior quality and even flow of metal.

We will now pass on to the metallic arc process as we use it in firebox work. Every welding operator considers himself your best welder, but an efficient supervisor knows his men and uses them according to their ability. When so much depends on a sound and thorough weld as in firebox work, employ only your highest trained men, men that have proven themselves by the actual result of their test stubs and whose ability is known beyond a doubt. Here perhaps more forcibly than in any other work, except flues, comes up the question of proper preparation before welding.

Fig. 7 gives a view of the fire side of two firebox side sheet seam welds, both beveled to a 45 deg. angle, one with a ⅛ in. the other with a ⅜ in. opening between the

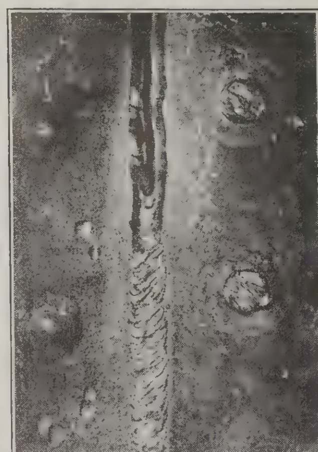


Fig. 10

Fig. 11

Fig. 10—A ¾-In. Side Sheet the Seam of Which is Being Electrically Welded

Fig. 11—Method of Welding a Side Sheet Patch

two sheets. Both appear on the face or outward appearance to be very successful welds. But electric arc welds like men are not always what they appear outwardly. Note the uniformity of the welded metal in these two specimens.

The result obtained in the two specimens can be seen from Fig. No. 8 which is a cross section view of these same specimens. Notice how the metal from the electrode is forced through the ⅛ in. opening and how it forms both corners of the "V" into a seam resembling a rivet head; also note the small amount of metal that is required to fill the "V" and properly finish the seam. This is the ideal prepared seam as it requires a minimum amount of electrode or added metal, and a minimum amount of heat which is of great importance in all firebox work. While the ⅜ in. opening as you see requires an excessive amount of welded material, and therefore, excessive heat. In the ⅜ in. opening or even ¼ in. opening you cannot unite the two sheets with one run of your electrode as in the ⅛ in. opening, but must first make two or more runs on your lower sheet in order to make the opening small enough to unite the two sheets. The side and door sheets being of from 5/16 in. to ½ in. steel gives you a very

narrow surface on which to build up, with the result that your inside corner is melted off and your metal after the first run will be very hard to control and as you are not able to see the back side, you get results similar to those shown.

An enlarged view of electrically welded side sheet

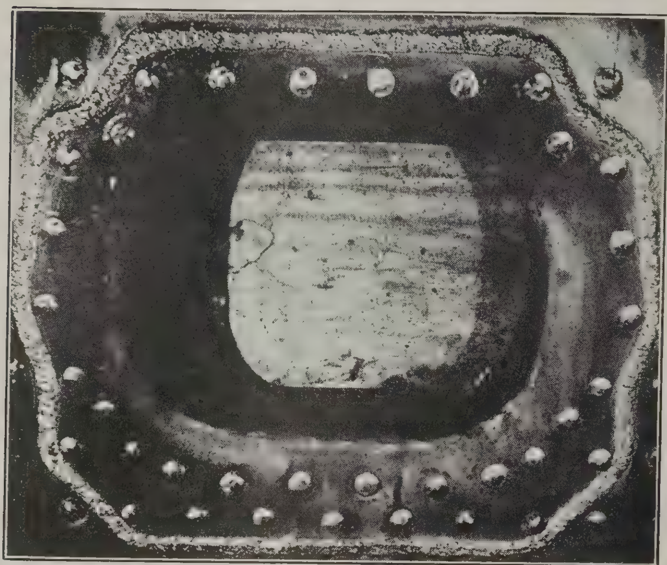


Fig. 12—Showing Practice of Welding in a Door Hole Collar

seams with 45 deg. bevel and a ⅛ in. opening may be seen in Fig. 9. Note the rivet head effect of the seam and the line of heat penetration or change in structure of the parent metal.

Fig. 10 is a ¾ side sheet the seam of which is being electrically welded. You can readily see the process of the two runs of the electrode, which completely finishes

Fig. 13

Fig. 14

Fig. 13—A 2-In. Flue Welded with ⅛-In. Electrodes Using 140 Amperes and 21 Volts Across the Arc

Fig. 14—Flue Welded Under Same Conditions As Fig. 13 Excepting No Water Was Used in the Boiler

the seam. With a 45 deg. bevel in the two sheets with a ⅛ in. opening, the welder is able to completely unite the two sheets and fill in about one-half of the "V" with the first run of the electrode. Care must be taken not to proceed too rapidly so as to avoid an excessive amount of heat in the two sheets. Proceed slowly and weld thoroughly with your first run and you will never have one of these seams crack for you. The iron oxide (that has formed) should be completely brushed away with a wire hand brush, using a hand hammer and chisel to remove any slag that has been formed on the edge of the "V." The second run of the electrode should completely fill the remainder of the "V" reinforcing the weld about 1/16 in. and extending beyond the two edges of the "V" about ⅛ in.

Prepare your seams in a straight line, but in door collars and all patches, studiously avoid square corners. Fig. 11 illustrates a side sheet patch and Fig. 12 shows the practice in welding in a door hole collar.

No electric arc weld is as strong as the original sheet for the simple reason that the metal deposited through the arc is necessarily a cast metal, while your sheets are forged or rolled steel. Therefore, the more thorough your preparation of the sheets and the less welded material in your seams, the stronger your finished job. Use a ⅛ or 5/32 electrode, with the chemical properties about as follows:

Carbon not over	0.18
Manganese	0.64
Sulphur and phosphorus	0.05

Electric arc welding gives a stronger seam than riveting and there is never any future work necessary, such as

Fig. 15

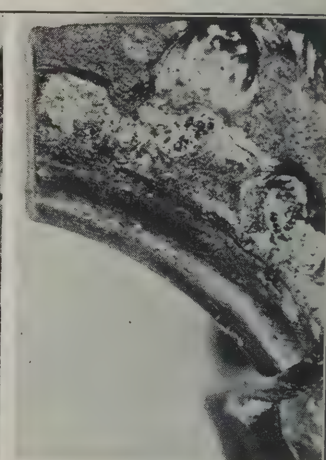


Fig. 16

Fig. 15—Flue Set the Same as Figs. 13 and 14, Welded with a Current of 140 Amperes with 26 Volts Across the Arc

Fig. 16—Showing the Necessity for Cleanliness and Proper Preparation

caulking. Your riveted seams give about 60 per cent of the strength of the original steel, while I have gotten as much as 96 per cent in an electric arc weld.

I have a test report here that I want to give you just to show what results are possible in metallic electrode welding. These tests coupons were welded under the same conditions as I have described in the firebox, seam welded and are the results obtained by three of my welders.

Specimen	Elongation in 2 in.	Load Pounds per sq. in.	Efficiency
1	6.5%	42,700	
2	8.5%	52,800	
3	8.5%	52,800	
Avg. (above)	6.7%	47,700	86.7%
Avg. (3 others)	7.0%	51,400	93.5%
4	8.0%	51,900	
5	8.0%	53,300	
6	7.0%	51,400	
Avg. (above)	7.7%	52,200	94.6%

The original tensile strength was 55,000 per square inch.

These coupons were ½ in. boiler steel which were shaped smooth before testing, leaving no welding reinforcement.

These tests were made at the Ohio State University by Professor D. J. Demerest, Professor of Mines and Metallurgy.

Now the next question in your mind, no doubt, is what is the cost in comparison with a riveted seam. I will say in so far as I have investigated, that to rivet in these seams (labor and material) it will run from 90c to $1.25 per lineal foot, while with the metallic electrode these seams, electric energy at 3c per k. w. hour (140 amperes at 92 volts or 22 volts across the arc), will cost per foot, .09c, 5/32 electrodes at 7.5c per lb.; per foot, .05c, 25 min. time for welder operator (a) 50c per hour; per foot, 21c, making the entire cost per lineal foot 35 cents.

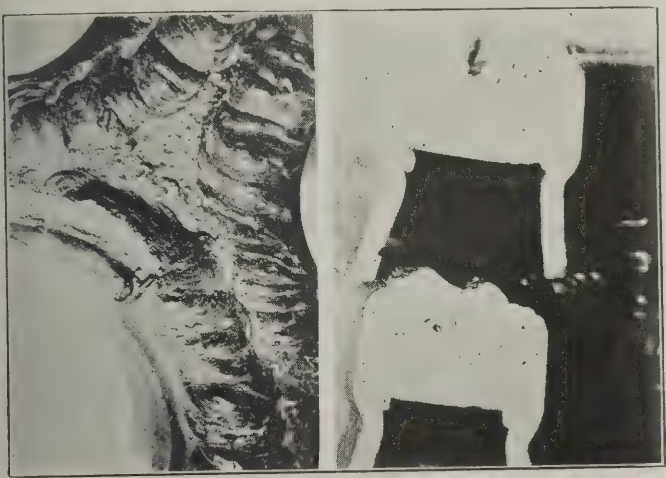


Fig. 17 Fig. 18

Fig. 17—When Not Properly Prepared There is an Uneven Application of the Metal

Fig. 18—Showing the Right (below) and Wrong (above) Methods of Placing the Copper Ferrule Prior to Welding

The question of proper procedure and method of flue welding is an open one and perhaps some of you may differ with me on the subject. I am not prepared to say that the method we pursue is best, but am simply going to give you a few facts as I have found them.

First, last and always, I am talking and insisting on proper preparation before welding any job, and in flue welding cleanliness and proper preparation are the first considerations. If your flue sheet is a new one, sand blasting thoroughly will give you a clean sheet; if an old sheet and one that has been welded before, the previous weld must be chipped clean from the sheet. Place your copper ferrules so that after rolling them in place they will set back from the fire side of the sheet about 1/16 of an inch. This will leave your copper back far enough so that when the flue is expanded and beaded down the copper ferrule will not interfere with your weld. Set your flues in the usual manner, leaving the small flues extend through the back flue sheet about 3/16 of an inch and the superheater flues ¼ of an inch.

The boiler is then given the regular hydrostatic test and all leaking flues tightened, for if your flues are not tight in the sheet before welding, they will not be after. Keep oil and grease off the flue bead and sheet. Now sand blast your flues and sheet clean of all dirt and scale, bead down your flues tight against the sheet, or your beads will burn off in welding, fill your boilers with water and you are ready to weld.

Start at the top of the sheet and progress downward, starting each flue at the bottom, progressing first up one side, then the other, meeting at the top of the flue. Weld first to your flue sheet out from the flue bead the thickness of your welding wire or 5/32 of an inch, then by a weaving movement weld to the crown of your flue, bead back and forth until you have completed the flue. This will give you a strong weld on the sheet and enough metal on the flue beads to protect them.

Fig. 13 shows you a 2-inch flue, welded with ⅛ inch electrodes, using 140 amperes and 21 volts across the arc. In this case the copper ferrule was properly set so as not to interfere with the welding. The flue beaded down tight against the sheet. No oil or grease was used on the flue sheet and the sheet was cleaned with the sand blast. The boiler was then filled with water and welded. This flue was then sawed horizontally and the strip of flue bent back and forth and finally broken off by a hand hammer and chisel. Notice how smooth and uniform the weld is applied in this case.

Fig. 14 was welded under the same conditions as the previous flue, excepting no water was used in the boiler. There was no oil or grease on the sheet or flue and the copper ferrule so placed as not to enter into the weld.

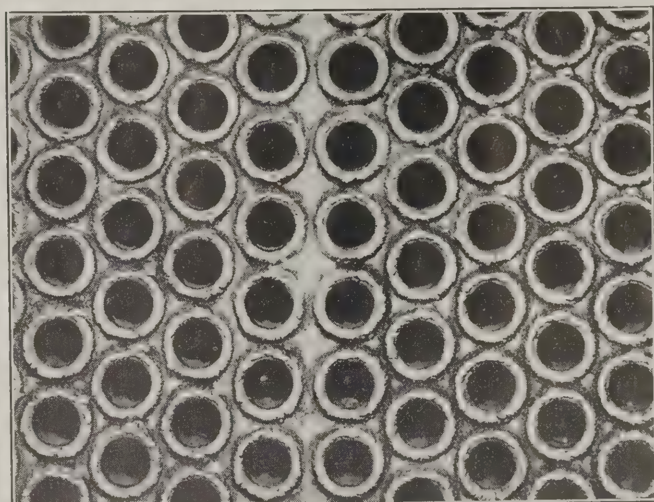


Fig. 19—Showing a Flue Sheet in Which All of the Flues Have Been Electrically Welded

Note the clean metal shown when this flue was broken down and the perfect penetration and fusion of the weld. These two flues were each welded by a different operator.

A flue that had been set just the same as the preceding two (no oil or grease used, sand blasted clean, copper ferrule placed as in the other two) is shown in Fig. 15. The amperage, however, was 170 with the voltage across the arc at about 26. When this flue was sawed horizontally and bent back the whole weld popped off the sheet.

You can readily see by the pocked and cinder appearance just what took place in this case. The welder operator who did this work also welded the first flue shown.

Fig. 16 shows a result quite different from the preceding illustrations, and shows very convincingly the necessity of cleanliness and proper preparation. In this flue the copper ferrule was placed in the sheet and allowed to come

flush on the firebox side with the result that when the ferrule was rolled tight and the flue set and beaded down the copper protruded out under the bead. Oil was used freely on sheet and flue bead. You can readily see how this copper ferrule extended out under the flue bead and how it was burned out by the metallic electrode.

Note the porous and slag like appearance of the metal. This condition is caused by the burning of the copper and oil by the steel electrode, which forms a copper monoxide gas. This gas being densest at its source, which is the flue bead and sheet prevents the molten metal from the electrode from properly fusing with the parent metal, and the entrapped vapors in liberating itself forms the slag like porous structure that you see.

Fig. 17 shows the result of the same preparation as the previous one. Note the appearance of the welded metal, also the uneven application of the metal, how it has splashed and run down. With a clean properly prepared flue job your welder is able to apply the weld in a uniform manner, progressing rapidly and thoroughly as the metal penetrates or dives in and is readily controlled. While in an oil soaked and dirty sheet or one with the copper ferrules interfering your metal has not that snap—that clean fusion or penetration. You cannot progress with regularity as your arc is unstable and the metal backs up on the electrode and runs down on the sheet.

A cross section view may be seen in Fig. 18. Notice how the copper ferrule is placed in these two flues. One placed 1/16 back from the fire side of the sheet with the result that we have perfect penetration and a clean weld. While in the other the copper ferrule was allowed to extend out under the bead with the result as you see it here, poor penetration, porous metal, and an excessive amount as in welding under these conditions, your metal backs up and runs out.

Fig. 19 gives a view of a flue sheet in which all the flues have been electrically welded. The cross denotes the center of the sheet and divides it into four parts, each welded by a different operator. Note the smooth and uniform welds.

In welding in flues with the metallic arc process the cost per flue is as follows:

Electric energy	\$.017
Labor at 78c. per hour	.025
Metallic electrode material	.009
Total cost per flue	\$.051

In closing let me urge that we all, welding engineers, supervisors, and welder operators, do our utmost and be ever alert to eliminate the abuses that are liable to occur in electric arc welding; for the more perfect our results the greater the demand for our work. We know that no other method of new or repair work, within its limitations can be done as economically as by electric arc welding.

New Ferryboats for New York Harbor

A NOVEL application of turbine electric drive for ships is instanced in its forthcoming application to three municipal ferry boats for New York harbor, which will run between St. George, Staten Island, and Manhattan. These will be the first ferry boats to have turbine electric drive, the other electric ferry boats built, or in process of building, being equipped with Diesel engine electric propulsion.

The three boats will be equipped by the General Electric Company with propulsion equipment comprising one 2,200 shaft horsepower—3,240 r. p. m., 2,300-volt, 3-phase, a. c. turbine generator, which will supply power to two 2100/100 shaft horsepower—176/122 r. p. m., 36/52 pole, 2300 volt, 3-phase induction motors, one driving each propeller. In addition there will be two 125 kw. 3,600/1,200 r. p. m., 110/220 volt d. c., three wire turbine driven exciters, which will supply power to the electric auxiliaries as well as excitation current. Control of the apparatus will be obtained through a control panel in the engine room.

It is believed that there will be considerable saving in the propeller horsepower, and consequently in the coal consumed, by driving these boats, which are double-ended, by means of the stern propeller, idling the bow propeller so as to offer the least resistance. This accounts for the double rating of the motors, for when used as bow pilot motors they will operate at 100 hp., 122 r. p. m. and when actually driving the boat they will operate at 2,100 hp., 176 r. p. m. Provision for the automatic shifting of the poles is made in the control switchboard, by contactors controlled by means of a master controller located in the control panel or manually operated levers. It is calculated that the boats will effect considerable saving in operating expenses, due to the economy of the turbine electric form of drive.

The new boats are designed primarily to handle trucking business across the bay and the lower decks will have four driveways for this purpose. There will also be passenger accommodations on the upper deck. The boats will have a length over guards of 216 feet, an overguard beam of 64 feet, the depth of the hull, amidships molded, will be 18.5 feet, and the beam of the hull at the deck, molded, will be 45 feet.

P. & A. Photo

The Baldwin Locomotive Works' Exhibit at the Brazilian Exposition, Rio de Janeiro

The wheels turn but the train does not move. The scenery moves, however, carrying out perfectly the illusion of a moving train

The Advance in Industrial Electric Traction

A Description of the General Construction and Motor Arrangement on Various Types of Small Locomotives

By Gordon Fox

Part II

THE gear ratio used on a locomotive or car has an important bearing upon its operation. Where the movements are short and there is more or less spotting or inching, it is advantageous to have a high gear ratio. The relatively low free running speed is not a

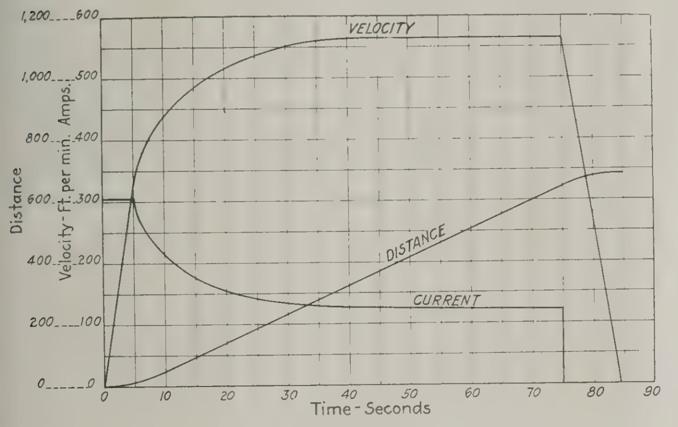


Fig. 2.—Velocity and Distance Time Curves

serious disadvantage and the ability to accelerate quickly with minimum motor capacity and minimum power input are decided advantages. The best procedure is to plot a number of speed-time and distance-time curves with various gear ratios and to determine from these the com-

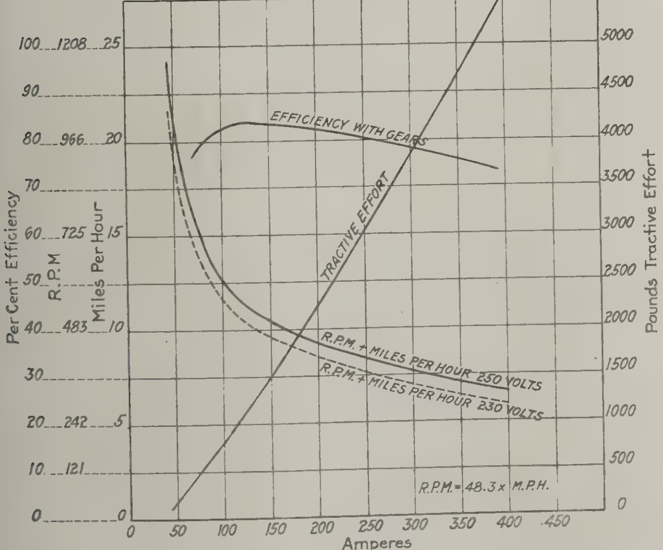


Fig. 3.—Characteristic Curves of Series Railway Type Motor

bination best suited to the work in hand. Fig. 2 is a curve of this nature showing also the motor current input. These curves apply to a transfer car weighing with load, 165,000 lb. The car is equipped with two 55 hp.—250 volt series motors connected permanently in series. The characteristics of this motor are shown in Fig. 3. Some of the pertinent data and calculations for these curves follow:

Weight of car and load = 165,000 lb. = 82.5 tons.
Train resistance taken at 20 lb. per ton.
Free running tractive effort = 1,650 lb.
Free running speed = 565 ft. per min.

$$\text{Free running hp.} = \frac{1{,}650 \times 565}{33{,}000 \times .85} = 33 \text{ hp. for 2 motors.}$$

Rating of motors = 55 hp. at 230 volts.
$27\frac{1}{2}$ hp. at 115 volts.

$$\text{Free running load} = \frac{16.5}{27.5} = 60 \text{ per cent of rating.}$$

Motor speed at 60 per cent load — 115 volts = 314 r. p. m.

$$\text{Ft. of car per rev. of motor} = \frac{565}{314} = 1.8.$$

Dia. of wheels = 33 in.

$$\text{Gear ratio} = \frac{\pi \times 33}{1.8 \times 12} = 4.75 = \frac{76}{16}$$

Full load motor current = 203 amp.
Av. current in starting = 203 × 1.5 = 305 amp.
Tractive effort per motor in starting = 3,900 lb.
Tractive effort of two motors in starting = 7,800 lb.
Less train resistance of 1,650 lb. = 6,150 lb.
TE required per ton for 1 ft. per sec. = 67.5 lb.
For 82.5 tons = 5,570 lb.

$$\text{Acceleration rate} = \frac{6{,}150}{5{,}570} = 1.1 \text{ ft. per sec.}$$

In starting, the motors are across the line in series at 305 amp., corresponding to 182 r. p. m. and 328 ft. per min.

$$\text{Av. velocity during acceleration} = \frac{328}{2} = 164 \text{ ft. per min.}$$

Distance traveled during acceleration $= 164 \times \frac{5}{60} = 13.7$ ft. Braking rate taken at 1 ft. per sec.

The velocity curve is based on uniform acceleration at 1.1 ft. per sec. and free running speed of 565 ft. per min. The points on the curve, after the motors are across the line and the acceleration rate falls off, may be found by taking increments of motor current, determining the resulting average torque and consequent rate of acceleration and the velocity attained. This, when plotted, determines the time for the increment. The distance curve is derived from velocity time values.

It should be noted from these curves that a distance of some 350 ft. is traversed before the car reaches full running speed. For any distances less than 13.7 ft. the motors operate with starting resistance in circuit. The higher the gear ratio, the more quickly the motors reach their speed and the more quickly the starting resistance may be cut out. It is evident that, for short movements and spotting service, a high gear ratio is advantageous.

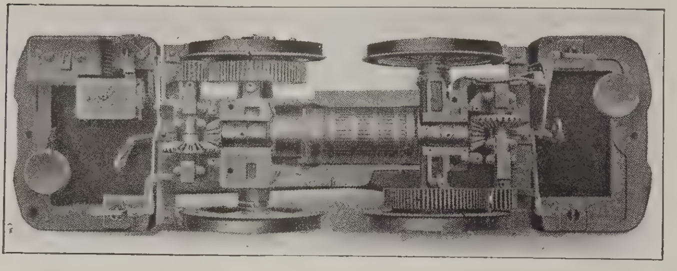


Fig. 4.—Single Motor Drive. Motor Mounted Longitudinally and Driving Both Axles Through Bevel and Spur Gears

The particular car described above is somewhat liberally motored, in that it is occasionally called upon to handle some trailing load. The motors are connected in series to obtain a low speed with a single gear reduction.

Where the movement of a locomotive or car is fairly regular and continuous, it is well to check the motors selected as to heating. This may be done by determining the equivalent continuous or root mean square current. The currents during acceleration and free running periods are squared and multiplied by the corresponding time periods. Their sum is divided by the total time, the idle and low speed running times being discounted

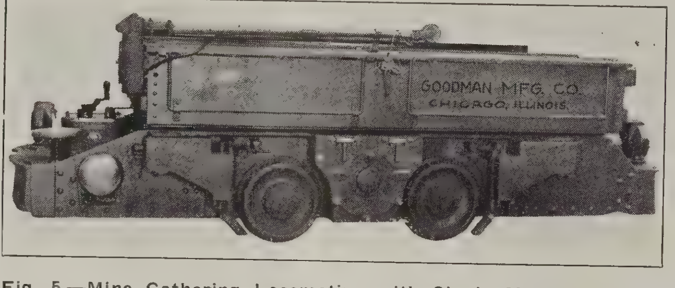


Fig. 5.—Mine Gathering Locomotive with Single Motor Centrally Mounted and Driving Both Axles

because of reduced heat dissipating ability. The square root of the result is the r. m. s. current, which should not exceed the continuous current rating of the motor selected.

The calculations outlined above may be best performed through use of the motor characteristic curves, such as shown in Fig. 3. First determine the tractive effort per motor for each portion of the run, as where different grades or curves are involved. For a given tractive effort find on the curve the corresponding current and speed. From this speed and the length of the portion determine the time for the portion. Add the (time × current squared) values for all portions for one complete trip. Divide by corrected total time and take the square root of the result. Where starts are a frequent and controlling factor, the accelerating tractive effort and current should be specifically computed and considered. It has been found that in mine locomotive service the acceleration requirement may be approximated by increasing the sum of the running (time × current squared) values, 10 to 15 per cent.

Industrial cars, which have no trailing load, commonly carry about 0.75 to 2.0 hp. in motor capacity per ton of total weight. Locomotives are provided with 6 to 12 hp. per ton weight. The tractive effort at which steel wheels will slip on dry rail, based on 25 per cent traction, on a locomotive geared for 10 miles per hour, corresponds to developed motor capacity of about 13 hp. per ton of weight. When better adhesion is obtained, still higher values will be necessary to start the wheels to slip.

The motors employed for industrial electric traction service are, for the most part, railway type motors of standard or semi-standard design. The wide variety of track gages now in use has made standardization of motor equipment rather difficult. Due to the low speeds usually desired in industrial service, motors of low speed rating are commonly used. The voltage is usually 230 volts or thereabouts because this is most common for general industrial service, because transmission distances are short and the danger of exposed collectors less and because batteries are feasible for this voltage. In mine service the voltage is limited due primarily to danger from the exposed trolley wire and more specifically by

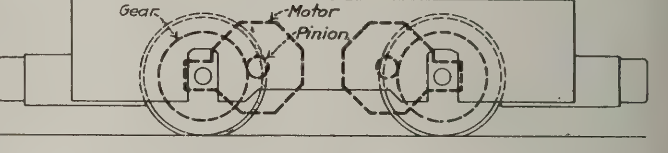


Fig. 6.—Two Motor Drive. Motors Hung Centrally

state regulations. Series motors are used almost exclusively. In occasional cases, alternating current wound rotor induction motors are employed. They are not well adapted mechanically and are inferior to direct current series motors in characteristics for traction service. Direct current mine type and vehicle type motors are both used for mining locomotives and for narrow gage service. Some of these motors are arranged with two gear reductions. Railway and mine type motors are nominally rated on the basis of 75 degrees Centigrade rise in one hour.

A variety of practices are followed in the mechanical

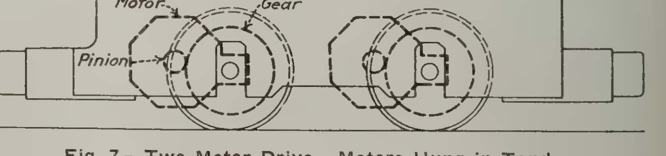


Fig. 7.—Two Motor Drive. Motors Hung in Tandem

application of motors, particularly in mine locomotives, due to the varying requirements. It may be in order first to mention single motor vs. multiple motor equipments. Due to the fact that the draw bar pull of a locomotive is some distance above the track, this pull, together with the forward tractive force at the rail, give rise to a couple which tends to increase the weight or pressure on the rear wheels of the locomotive and to decrease the pressure on the front wheels. Consequently, with a multiple motor arrangement, the front wheels will tend to slip first. The tractive effort is therefore restricted by the slipping point of the front wheels. Weight

transfer due to draw bar pull is relatively great in locomotives having a short wheel base and a high draw bar. To overcome this difficulty connecting rods or chains may connect the front and rear wheels. It is not an uncommon arrangement to install a single motor driving to both axles through bevel gears, worm and wheel or chain drive. Fig. 4 illustrates a motor arranged longitudinally and driving both axles through bevel gears. This arrangement assures maximum utilization of the locomotive weight and is well adapted to narrow gages. In another arrangement a single motor located between and above the axles drives gears on both axles from a single motor pinion through intermediate gears. This arrangement gives a short wheel base and compact construction.

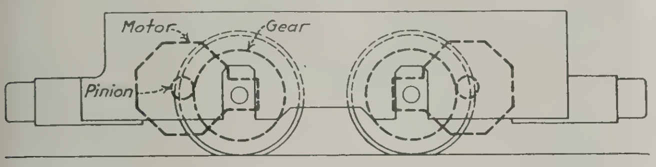


Fig. 8.—Two Motor Drive. Motors Hung Outside

The most common practice, particularly with main haulage locomotives, is to suspend two or more motors from the two or more axles by means of axle bearings on the motor with a third point of suspension from the truck through a spring support. Where two gear reductions are used the intermediate gearing is made integral with the motor and located between the motor and the axle bearings. Ball and roller bearings are in common use on both mine type and vehicle type motors, particularly for the armature shaft. They give a shorter motor, tend to minimize armature scraping on pole pieces, maintain good commutator alinement and largely eliminate oil leakage from bearings into the motor. Axle bearings may be either ball or sleeve type. Because of the large journals, the axle bearings are necessarily large.

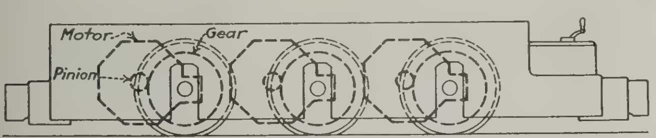


Fig. 9.—Arrangement of Motors on a Three Motor Locomotive

There are a number of methods of motor suspension in use. Two motors may be hung centrally, as shown in Fig. 6. This gives a long wheel base, which is desirable for long hauls and high speeds if short radius curves are not present. The arrangement is symmetrical and the motor weight is equally divided on the wheels. Tandem hung motors, as shown in Fig. 7, are most commonly used. This arrangement gives a medium wheel base best adapted to the general run of conditions. It is to be noted, however, that the motor weight is not equally distributed. Fig. 8 shows an arrangement with outside hung motors. This gives a short wheel base on a locomotive and is advisable only where sharp curves must be negotiated. This arrangement is frequently employed for industrial cars, as it brings the motors out at the ends of the car where they may be made most accessible. Mining locomotives up to about 15 tons are normally equipped with two motors. For larger sizes or where greater capacity is required than can be provided on two axles because of gage or other limitations, or where it is desired to distribute the weight over more wheels to enable the use of a heavier locomotive on a given weight of rail, three motor equipments arranged as shown in Fig. 9 may be used. Provision is made for equalizing the weight on the wheels with irregular track conditions, so far as may be done.

Some of the smaller industrial cars are provided with hand or foot brakes. These are not very effective or practical except for light equipments. Straight air brakes are commonly provided for large units, except that those which may operate on railroad trackage must be equipped with automatic air brakes. Mine locomotives of the smaller sizes are commonly equipped with brakes set by a hand wheel. Locomotives of about 12 tons and larger are equipped with air brakes. The control ordinarily provides for rheostatic braking and regenerative braking is employed for some of the larger mine haulage jobs. Plugging should not be used, as it is ineffective in case of loss of power. "Bucking" the motors is to be avoided as injurious to both motors and equipment. Where electric braking is employed the heating effect on the motors must be considered.

Drum control is most extensively used both in mining and industrial traction work. On some of the larger mine locomotives a magnetic contactor is used for breaking the arc, resulting when the controller is thrown off during a heavy pull. This represents the most severe duty on the controller. Magnetic control is used to a very limited extent largely because of space considerations. Electric pneumatic control is used on a few industrial locomotives. Series parallel control is widely employed both for 2 motor and 3 motor installations. Arrangement is sometimes also made for optional full parallel control. Overload protection is provided on the smaller locomotives in the form of fuses. Circuit breakers are supplied on the larger units. A circuit breaker on a locomotive should be set for a current corresponding to the tractive effort of 40 per cent of the locomotive weight. The wheels will then slip before the breaker trips, but short circuit protection is afforded. Slippage of the wheels is the most effective overload protection of locomotive motors. Industrial cars do not have sufficient motor capacity to slip the wheels, hence they must depend solely on the fuses or circuit breaker.

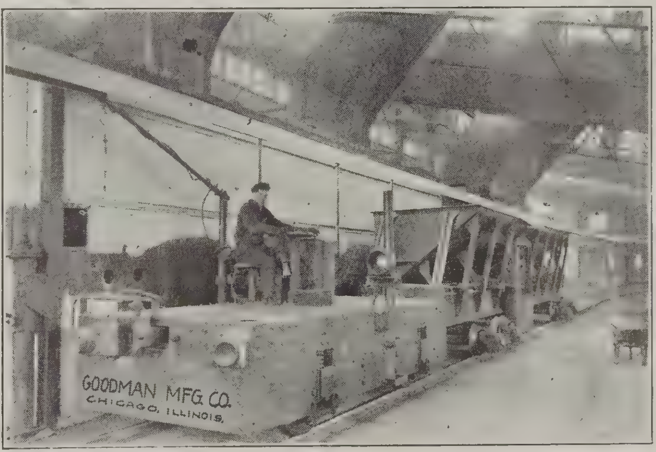


Fig. 10.—Industrial Locomotive at Work

The determination of battery capacity for a storage battery locomotive is a somewhat mooted question and opinions differ as to procedure and practice. One method which is sometimes followed will be outlined. The first step is the determination of the total watt hours required for a typical round trip or cycle, this being a combination of separate determinations for each portion of the cycle involving different grades or train weights. A figure of 60 per cent may well be taken as the efficiency from battery to wheels, covering both motor and control losses. In this connection the following formula may be of use, being applied separately for each set of conditions:

Watt hours = .0006 × tractive effort in lb. × distance in feet.

Dividing the watt hours by the average battery voltage, gives the ampere hours delivered by the battery per trip. Multiply by the number of trips between full charging periods to obtain the total ampere hours of battery capacity required. The battery may then be selected on the basis of its 6 hour rating provided the service involves a large number of trips and a discharge period of 6 hours or longer. If the discharge period is shorter, or if a few trips only are involved, leading to relatively high rates of discharge, the battery must be selected on the basis of a much shorter time rating. When occasional boosting charges are possible, or when the locomotive operates from both battery and trolley, the question becomes further complicated.

The efficiency of storage batteries in traction service varies according to service, but is of the order of 50 to 70 per cent. The overall efficiency of a battery locomotive is about 40 per cent as compared with about 70 per cent for a trolley locomotive.

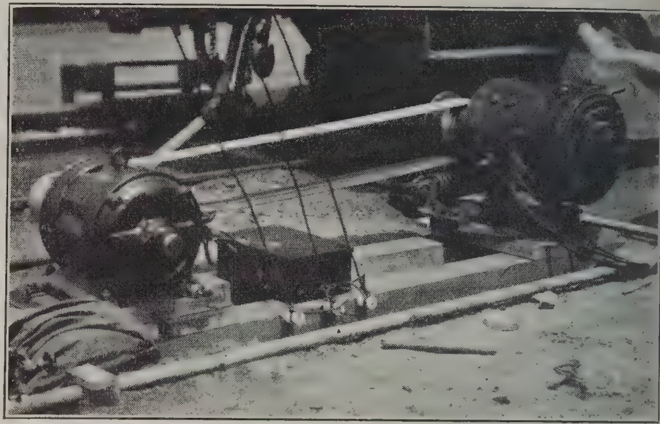
In connection with industrial haulage mention should perhaps be made of cars pulled by cables on short, straight runs or on cable roads and by means of car hauls. The determination of motor drives for these equipments follows the general lines of traction methods.

Thrift is a general moral tonic. It develops character. It takes self-denial, and hence creates self-mastery, which is the thing any human being most needs.

Illuminating a City on Wheels

There was a problem connected with the illumination of the 160 Pullmans, diner, etc., used to house 2,500 of the 30,000 members at the Knights Templar conclave held at New Orleans recently. As the meeting lasted three days some means of lighting the cars aside from the regular storage battery equipment was, of course, necessary.

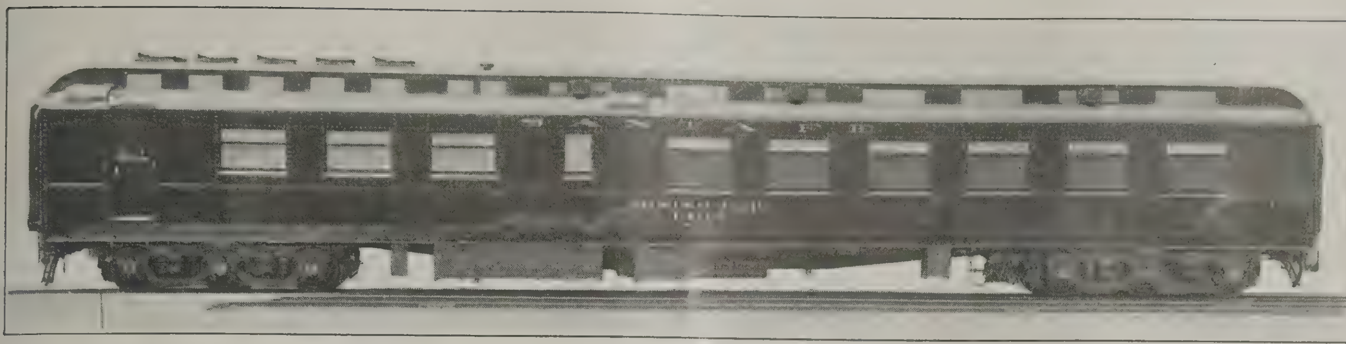
The electrical department of the Illinois Central arranged in advance to provide motor-generator sets to charge the car lighting storage batteries. The Pullmans were parked on 11 tracks and from 7 to 9 cars were charged from each of the 23 generating sets. As shown in the illustration, a regular 32-volt d. c. car lighting generator was mounted on a temporary frame with and belted to a 440-volt, 3 phase, 10-horsepower alternating current motor. The a. c. power was furnished by the New Orleans Railway & Light Co.



Motor Driven Generators Supplied the Necessary 32-Volt Power

No lighting car failures were experienced during the entire conclave. The engineering, installation, maintenance and removal of this extensive temporary lighting equipment, including the lighting of the yards, was handled by the electrical department of the Illinois Central.

One of the 2-10-2's Put into Service on the Rock Island in 1921



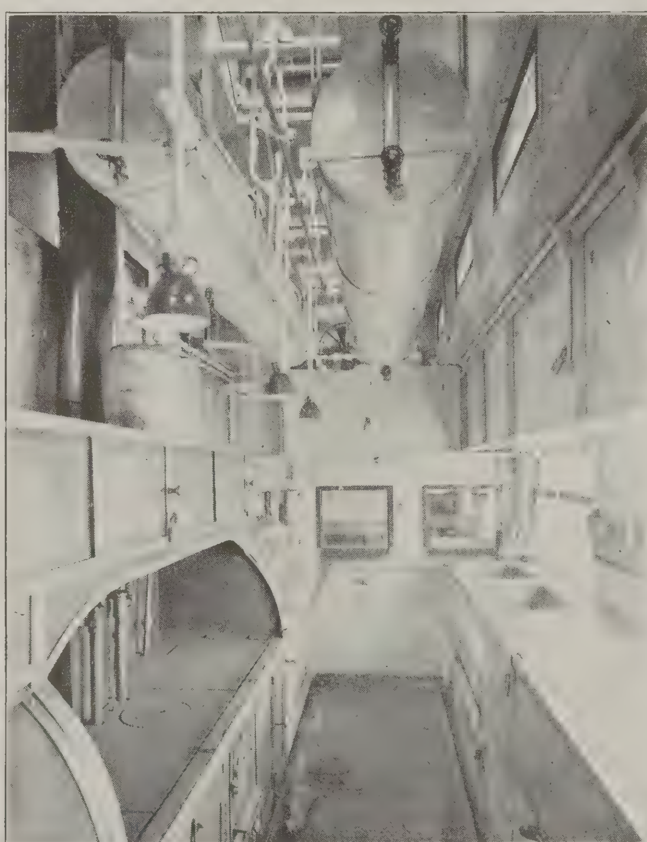
Santa Fe Dining Car from the Kitchen Side

Santa Fe Acquires New Steel Dining Cars

Two Sets of Battery Used to Secure Capacity While Circuit Arrangement Facilitates Economical Switching

THE Atchison, Topeka & Santa Fe has recently received from the Pullman Company eight all-steel dining cars. The cars are without vestibules, are 80 ft. 6 in. long over the end sills and weigh 171,000 lb. The dining rooms are 38 ft. 8 in. long and have a seating capacity of 36 at six single and six double tables. The tables are spaced 6 ft. 5 in. apart from center to center, which is 2 in. greater than the spacing on the older diners of this road.

Daylight View of the Dining Room



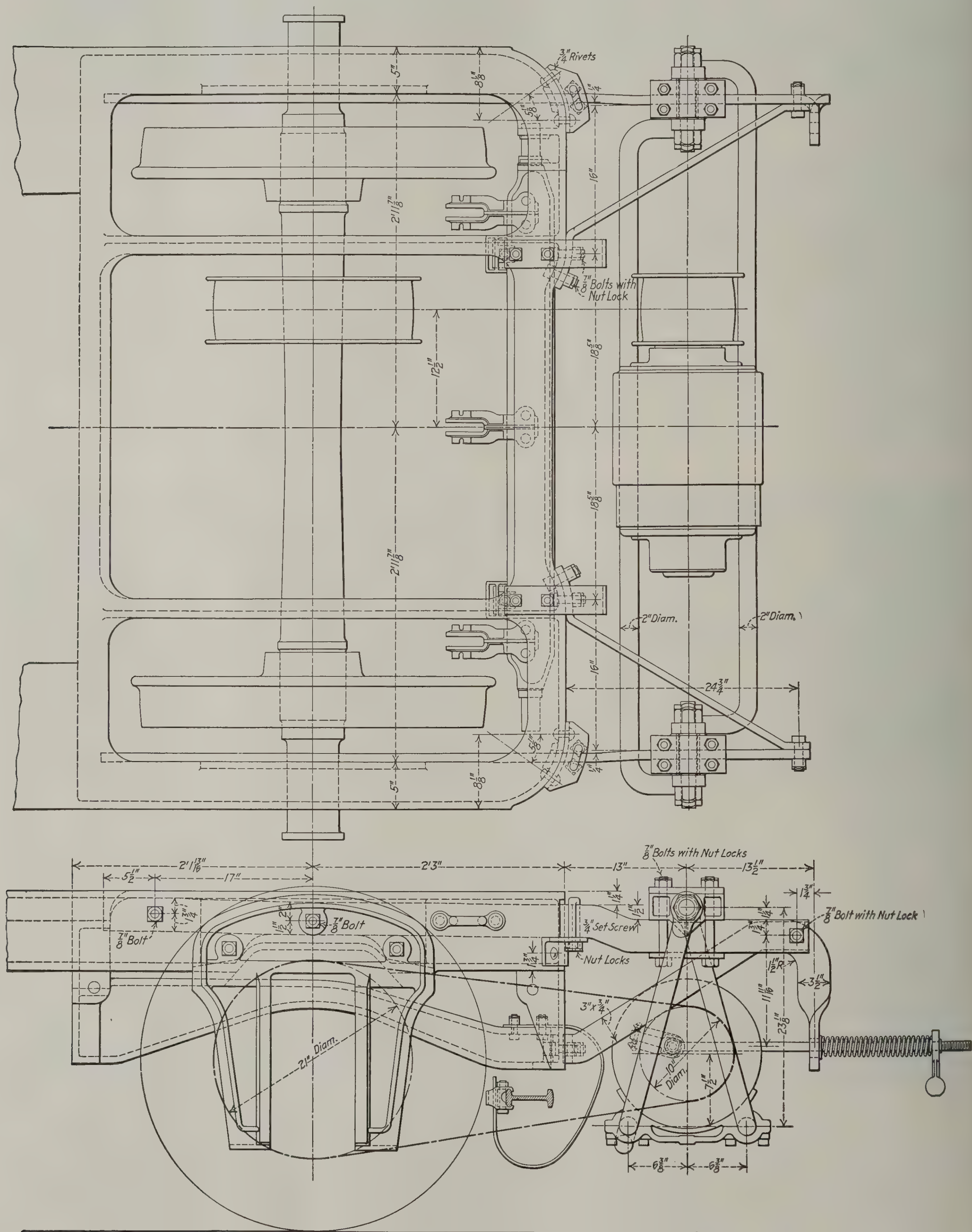
The Kitchen, Looking Toward the Pantry

Essentially the design of these cars is the same as that of the other all-steel equipment of the Santa Fe, the first of which was built in 1914. The underframe is designed to carry the load and consists of fish-belly center sills built up of plates and angles, channel side sills, and bolsters and cross bearers built up of channel pressings and cover plates.

The interior finish of the dining room is of wood throughout and is built up of five-ply veneer Mexican mahogany. At all bearings, both on the sides and ceiling, the wood is backed with heavy canton flannel to prevent creaking. The steel interior finish in the kitchen, pantry and hallway is of 1-16-in. sheet steel, and is backed with one course of No. 12 fireproof duck secured to the sheets with glue.

The arrangement of facilities in the car is clearly shown

on the floor plan drawing. There are four refrigerators iced from the roof, the largest one located in the kitchen at the end of the car. Two of the others are located against the partitions at the kitchen end of the dining room, one on either side of the car, and the third against one of the partitions at the opposite end of the dining room. In addition to ice boxes in the kitchen and pantry, a large ice box for meat storage is located under the car, to which access is had through a trap door in the pantry floor.



Truck Suspension for Car Lighting Generator

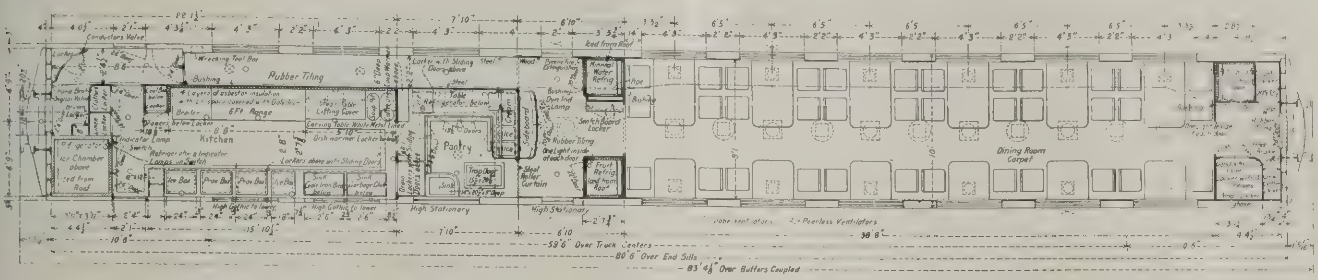
Side doors with 2-ft. 1-in. openings are located on either side of the car 4 ft. 4½ in. back from the end. The door from the corridor into the kitchen is directly in line with these doors. The outside door on the kitchen side is in two sections arranged so that the upper section may be opened independently of the lower.

Electrical Equipment

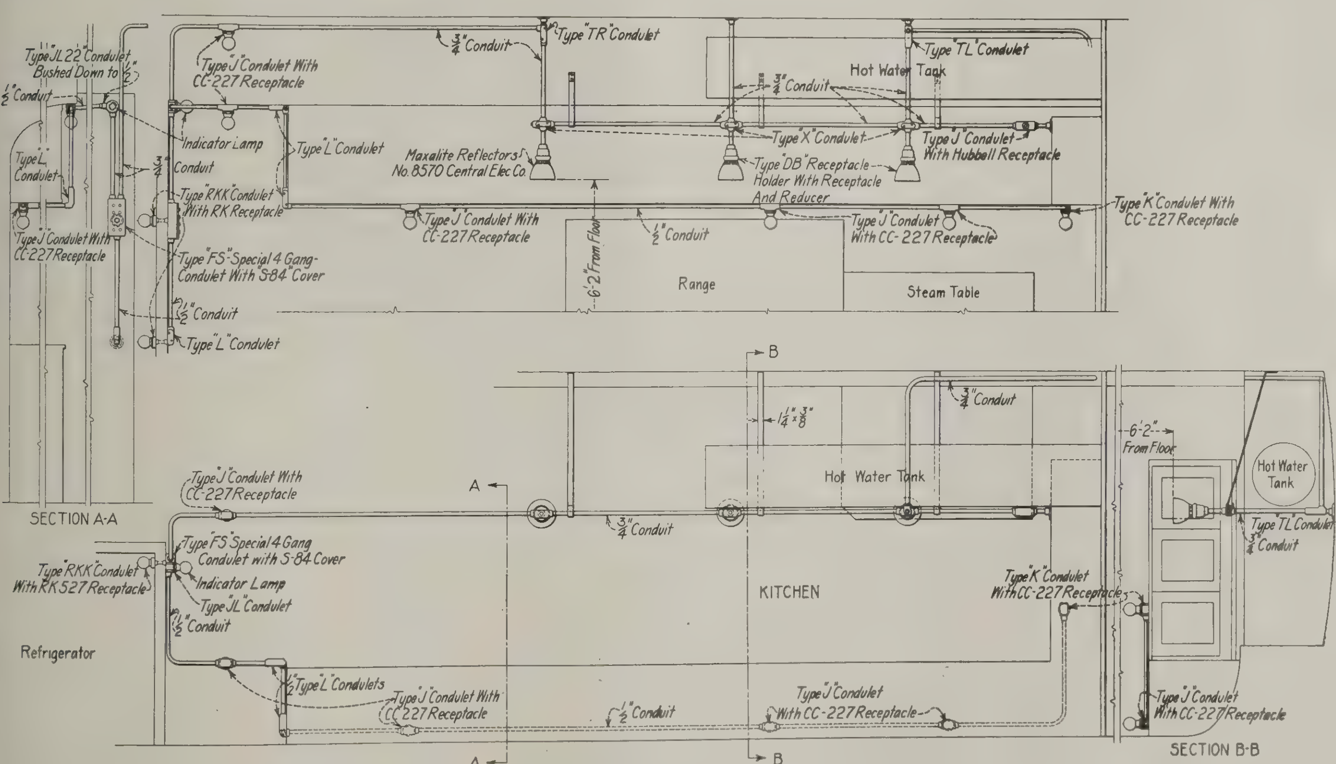
The electrical equipment consists briefly of a 4-kw. 32-volt, axle-driven USL generator and regulator supplemented by 2 sets of 16 cells each, lead type storage battery. The generator is belt-connected and carried by a truck suspension built to Santa Fe standard, details of which are shown in the drawing and photographs. This suspension gives the advantage of a minimum number of wearing parts. An average belt life of 80,000 miles and the fact that the Santa Fe has never lost a generator with this type of suspension are points in favor of this truck suspension. The axle pulley is 21 in. in diameter and 7 in. face.

Two Sets of Storage Battery Used

On account of the unusually heavy discharge of a dining car of this type, amounting to approximately 70 amperes, it was decided to use two sets of lead storage battery of 16 cells each in order to get the required capacity in ampere-hours, this battery having 480 ampere-hours capacity. Electric Storage Battery Company's E C S—13 type cells with 13 plates mounted in rubber jars are used. Rubber jars have been used exclusively on this road for years with satisfactory and economic results. The jars on these new diners have a large sediment space of 3 in. and according to past experience on this road it is expected that these batteries will not require cleaning for approximately 4½ years. The cells are placed four in a crate. The battery crates are made of long leaf pine and are not painted but are treated in boiling hot paraffine to prevent the acid attacking the wood. The battery box is especially deep to take the four cell crates and is constructed according to Santa Fe standard, the inside being painted with one heavy coat of 2/3 paraffine and 1/3 rosin applied hot.



Plan View of Car Showing Arrangement of Facilities



Arrangement of Conduit in the Kitchen

Distinct Loads on Separate Circuits

The various circuits are numbered and the sizes of wire used are shown on the wiring diagram. The constant load, which burns at all times when the car is in service during lighting hours, is concentrated on circuit No. 1.

This circuit includes the three lights in the side corridor and the platform lights, controlled from the switchboard and also one light in the passage way at the rear door, together with four center deck fixtures, which circuit may be controlled by a switch mounted in the end and outside of the switchboard locker.

The lights for the large refrigerator at the rear of the car and those for the kitchen are connected to circuit No. 2 and are controlled by three separate switches mounted on the end of the refrigerator. Two lights on the refrigerator and one on the outside on the front, are controlled by one switch. One light on the quarter deck over the side door and the several lights in the lockers are operated from a second switch while the three lights over the range and the one light opposite the side door are connected to the third switch. The electric fan in the kitchen adjacent to the pantry is on a separate switch.

All of the lights in the pantry are on circuit No. 4, the locker lights being controlled automatically by Perkins door switches. The six lights above the tables on one side of the car are on circuit No. 4, while the corresponding lights on the other side are on circuit No. 5, the four center deck lights being on circuit No. 6. The five fans along the center of the upper deck in the dining room are on circuit No. 7, and circuit No. 8 includes numerous locker lights.

A standard train line, consisting of two No. 2 B & S gage wires connects the Oliver automatic connectors located on each end of the car, and this circuit is connected to the switchboard with the same sized wire. One two-fingered connector is furnished with each car.

Conduit

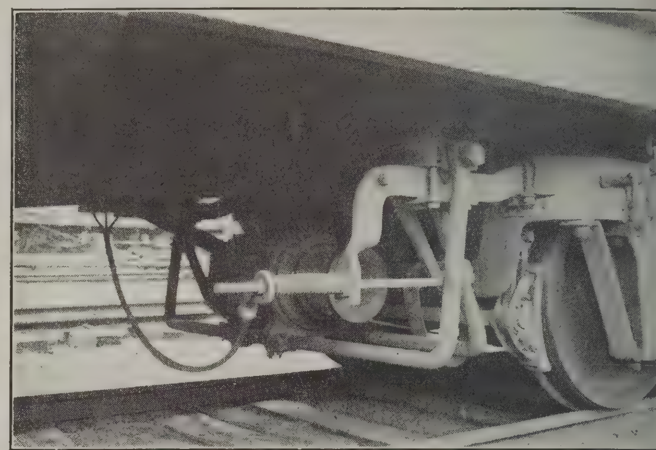
All wires are run in unlined, rigid steel conduits, none of which is less than ⅜ in. in diameter. The conduit system was first installed complete with all couplings, elbows, junction and outlet boxes, before any wires were pulled in. Joints were cut square and reamed out smooth and the conduit connected butt to butt in couplings so as to form perfect continuity. At all outlets, where outlet boxes are not used, the conduit is provided with P & B bushings. Both conduits and junction boxes are coated on the inside with baked enamel. Rigid supports are provided at intervals not exceeding five feet and the conduit boxes are securely fastened.

Wires

All wires larger than No. 8 B & S gage are stranded and no wires are smaller than No. 14. Okonite wire is used throughout. The dynamo lead wires are double braid No. 4 B & S gage, 600 volt, flexible switch cord. No joints or splices are made between outlet boxes, all such connections being located in junction boxes at terminals.

The Switchboard

The switchboard has one 3-pole, 60-ampere knife switch fused on the two outside blades only, and one 2-pole, 60-ampere fused train-line switch. These switches are fused with open link 2½-in. fuses. There are 10 two-wire circuits each provided with a 2-pole Edison plug fuse cut-out and a 2-pole push-button switch. The switchboard is placed in an unlined cabinet of 1/16 in. steel, provided with self-closing door. The regulator cabinet is of the same construction mounted above the switchboard.

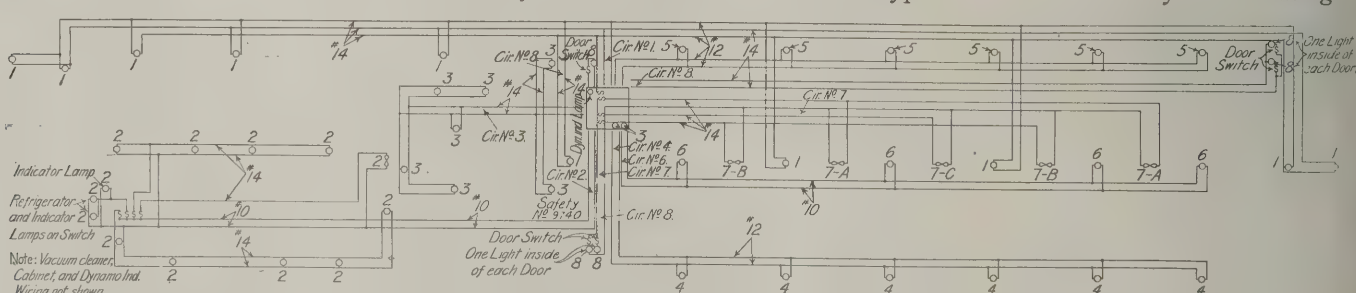


Type of Generator Suspension Used

Fixtures

The center lighting fixtures in the dining room are the diffused direct type 19129 of the Safety Car Heating & Lighting Company and the deck rail fixtures are type 19244. The pendants over the range are equipped with C. H. type "DB" holders with receptacles and Maxolite porcelain reflectors. The five fans in the dining room are the Safety Company's deck type, controlled by electrolier speed switches in the end of the switchboard cabinet.

The generator, belt, battery and bulbs were installed after the cars were received at the railroad company coach yard in Chicago.



Car Wiring Diagram Showing Arrangement of Circuits, Switches, Lamps and Other Outlets

Unassuming humbleness, patience and meekness are very desirable qualities in their right places, but very unfortunate when they are not subordinated to vigorous self-faith and an aggressive self-assertion.

Effect of Design on Headlight Maintenance

Cost of Turbine-Generator Operation Calls for Careful Consideration in Selection of Equipment

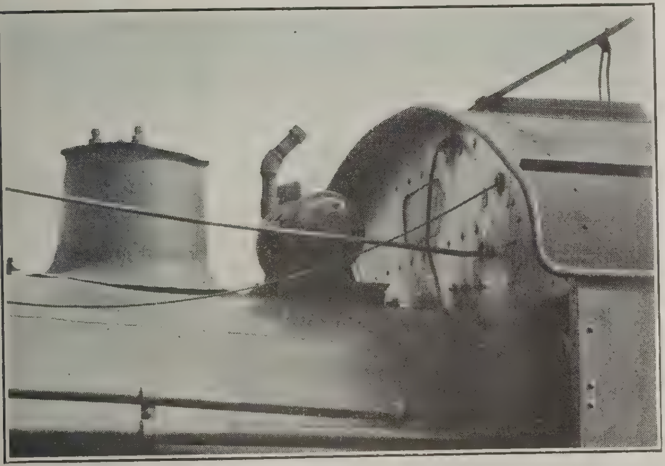
By R. Wayne Cargo

Westinghouse Electric & Manufacturing Company

HEADLIGHT turbine units seem to be a small item of equipment. The cost is about one fourth of one per cent of the total cost of a locomotive, yet this small part when considered for all the railroads of this country, will aggregate a large amount which is deserving of careful attention.

The following figures will give an approximate idea of the investment and cost of operating these units. It should be borne in mind that these figures are not based on any actual operating data, but rather are taken as approximate, and are used merely as an example to show what is invested in these installations.

A railroad having one hundred equipments at $125



Typical Installation of Headlight Unit on the Buffalo, Rochester & Pittsburgh Railroad Locomotive

each, has an initial investment of $12,500. Repair parts should be maintained in stock at all times, to the amount of $15 a unit. This adds to the initial investment $1,500, making the total investment, therefore, $14,000.

The maintenance, including labor on these units, will run from $50 to $100 a year, with say, an average of $75 a year. This will result in an annual maintenance cost of $7,500.

Turbine units will take about 200 pounds of steam an hour, and then to be in use an average of eight hours a day for three hundred days a year, the cost of steam at 50 cents per hundred pounds, will give a total of $24,000 a year for steam on these 100 machines. Including the maintenance cost, the operating cost is, therefore, $31,500 a year on 100 machines. This does not include oil or other minor items.

The performance of most of the units of today does not warrant a life of more than five years. Therefore, depreciation will be at the rate of 20 per cent a year, to which should be added interest on the investment at 6 per cent. Based on the $14,000 initial investment, this makes an addition of $3,640 a year to be added to the operating cost of $31,500. This, therefore, gives a total cost of $35,140 a year for operating one hundred turbine-generator headlight units.

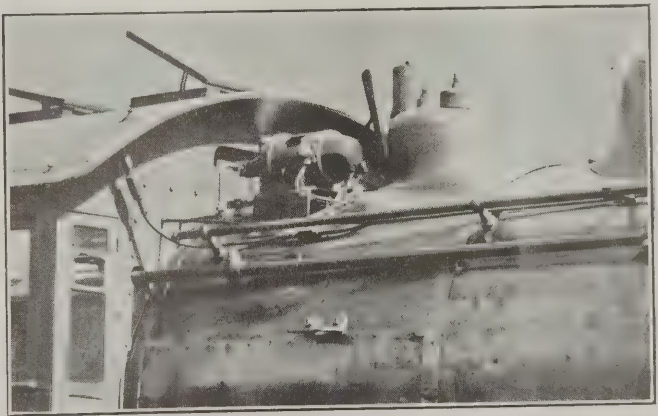
If these figures are extended to take in the thousands of equipments in service, it will result in a very large figure which merits the closest consideration.

One of the first considerations should be: Are these figures justifiable? In view of the performance of large turbine generator units for stationary work, they are not justifiable, even with the allowance made for the wide difference in the class of service. Other equipment on the locomotive includes nothing which would in any way nearly approximate these costs.

The main points to be considered in the selection of the headlight unit should be

1—Reliability
2—Ruggedness
3—Simplicity
4—Efficiency
5—Accessibility for inspection
6—Finish and workmanship.

Greater reliability is necessary in order to cut down the high maintenance charges and repair cost. The unit



The Headlight Unit As Mounted on the Pittsburgh & Lake Erie Railroad Locomotive

should not be selected on account of the ease of repair and the extreme accessibility, but rather the frequency of repairs, and cost of repair parts should be the prime consideration. A machine having a great number of wearing and adjustable parts is always subject to frequent adjustment and renewal. These are the items which make up the bulk of maintenance charges.

The class of service to which the headlight turbine-generator is subject is very severe, and calls for the most rugged construction possible. All of the parts should be heavy and well proportioned.

Special attention should be given to the bearings, to see that these are as large as possible, and in fact these should

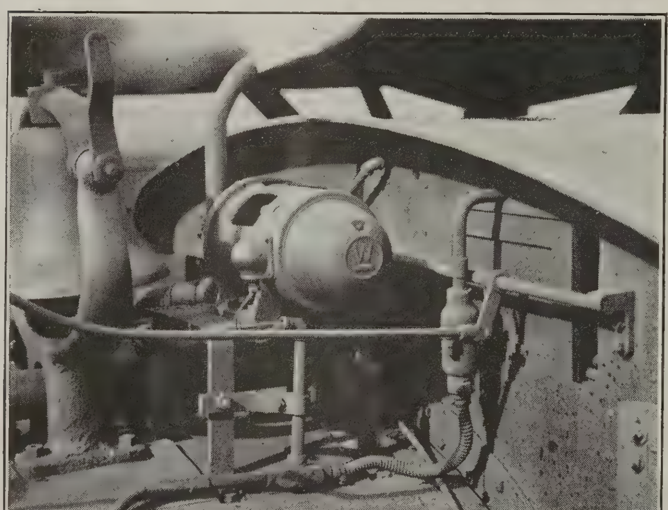
be larger than would ordinarily be called for in other classes of service. The best grade of self-alining ball bearings should be used.

The castings should be heavy to withstand the severe shocks and rough handling in operation. The design should be so arranged that there is no chance of difficulty from temperature or mechanical distortion of the unit. The preferable way would be to have only one bearing fixed in bolting the unit down; the steam and electrical ends of the unit should be unsupported, and, therefore, the unit would be free to expand, due to temperature differences. The bolting down should be so arranged that the unit would not be distorted when it is secured.

Due to the high rotative speed of the unit, there are heavy centrifugal forces set up. This, therefore, requires extremely heavy armature and turbine rotor. Also these should be of as small diameter as possible. The quill type of construction on the armature is not preferable in this class of apparatus, as the small diameter necessary for ruggedness cannot be obtained.

The turbine rotor should be especially designed to eliminate any distortion from heating or rough handling, as this would quickly put the unit out of balance. There should be enough metal in the rotor to readily obtain perfect balance. Stamped or forged, inserted blades will not lend anything to ruggedness, but rather, take from it. The rotor should be made of steel throughout, as cast iron or sheet iron will not give the desired strength.

Simplicity of design is very desirable. There should



One Method of Mounting the Headlight Unit as Used by the Long Island Railroad

be as few parts as possible in the whole unit, and especially the moving parts, which are subject to wear, should be at an absolute minimum. There should be as few adjustments as possible, which is only brought about through simplicity of design.

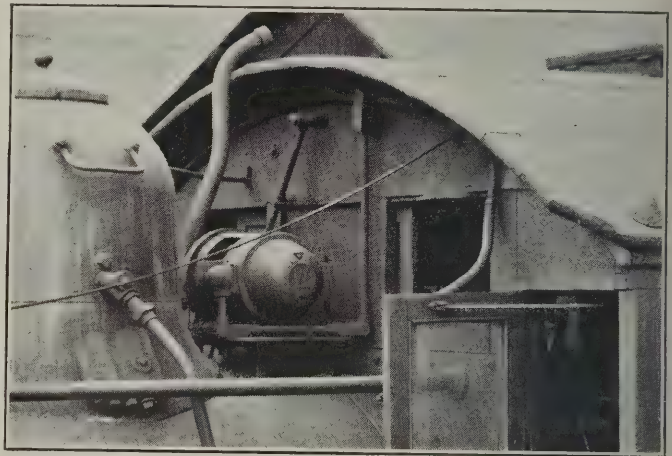
The governor should be arranged for the minimum number of parts, with the minimum number of adjustments. These parts should be rugged and accurately finished. The governor should be connected to the valve as directly as possible, eliminating all lever mechanism, which tends to stick and wear, and consequently, necessitates adjustment and replacement.

The inlet valve should be simple in design and operation. This part is subject to cutting from the steam, wear from the action of the governor and clogging up from accumulation of scale and boiler compound. There should be no long valve sleeves or stems which can become clogged with scale or subject to wear, with the consequent steam leakage and poor regulation.

Stuffing boxes on turbine shaft should be as simple as possible and not subject to adjustment. All manner of renewable or adjustable packing should be avoided.

On the generator end the wiring should be all inside of the frame so that connections should not have to be broken when dismantling. Connections from the outside should be made in such a way that the conduits or permanent wiring on the locomotive will not have to be disturbed.

Efficiency is an item which has not usually been given



The Union Railroad Mounts the Headlight Unit as Shown

the consideration it deserves. This has been on account of the fact that the first thought has been for reliability. If the unit were operated, which had a steam consumption of 125 pounds an hour instead of 200 pounds an hour, there would be a saving of $90 a year on each unit. This is based on the previous assumption of steam cost and length of operation. When extended to the great number of units in service, $90 a machine is no inconsiderable item. Efficiency, therefore, deserves the fullest consideration, along with the other items.

The units should be accessible only for inspection and not for repair or adjustment. A unit which is totally enclosed is the most preferable, as it eliminates the collection of dust, corroding gases, moisture and oil. While the unit should be enclosed, arrangements should be made for ease of inspection of interior, for trouble. Adjustments, however, should not be especially accessible and should not be many in number. They should be made only by authorized persons who are familiar with the unit, otherwise unauthorized persons are likely to make incorrect adjustments and spoil the operation of the unit. Ease of repair is not of greatest importance but frequency of repairs should be given prime consideration.

Workmanship and finish are items which should receive careful attention. The finish of the individual parts and the way they are fitted together reflect the ability of the manufacturer to turn out a reliable and rugged unit, as well as an efficient one. The finish will usually be the best index to the character of the machine. If the rotor is well made and well finished, there will be higher efficiency obtained. If the governor parts are made of the

best grade of material, accurately machined, with the elimination of pins, using in place carefully made knife edges and knife edge blocks, the regulation and operation of this governor will be far superior to one using rough cast parts and pivot pins.

By observing these various points of the machine, giving particular attention to the material and the finish, the purchaser or operator will be furnished with a very good idea of the reliability and efficiency of the machine which is in question.

Strength of Welded Pressure Containers*

THE following conclusions were reached as the result of an investigation of pressure tests on electric welded, gas welded and riveted pressure containers, similar to air reservoirs used in railroad service, furnished by the Vilter Manufacturing Company, Milwaukee, Wis. Tension and shear tests on specially prepared specimens of welded metals, also were made, demonstrating the strength and uniformity of construction secured by electric welding. In all nine containers were tested, using pressures from 200 to 2,100 lb. per sq. in. The containers were 15¼ in. in internal diameter and 10 ft. long with inserted dished ends held in place by electric welding.

Some of the more important points brought out by the tests are enumerated and discussed below.

Weak points in the containers. None of the welded containers of standard design failed primarily at the welded head joint. The nature of the fracture shows that the weak points in the containers were, first, the lap weld in the pipe forming the shell, where failure occurred due to circumferential tension, and, second, the body of the shell at its junction with the head flange, where failure occurred due to the combination of longitudinal tension and bending. It appears that leakage is likely to occur first where couplings and nipples are welded in. This is due to the fact that the metal of the shell stretches and pulls away from the nipple, which does not have a corresponding strain induced in it by internal pressure.

Strength of electric welds. From the tests on four specially prepared specimens, the average tensile strength of electrically welded joints was found to be 28,500 lb. per sq. in. From tests on five specimens cut from containers, the average shearing strength of electrically welded joints was found to be 25,500 lb. per sq. in. The mean variation from the average tensile strength per linear inch of weld was found to be 2 per cent, and the maximum variation 4.5 per cent. The mean variation from the average shearing strength per linear inch of joint was found to be 5.2 per cent and the maximum variation 7.8 per cent. The results of eccentric tension tests on specimens cut from containers showed that no one of the specimens was markedly weaker than the average for the lot. It is believed that the uniformity of strength thus indicated is of especial interest and importance.

In connection with the values given above for tensile strength, two points should be noted. First, at the section through the weld, where failure took place, the load was eccentric, because of the fact that the specimen is unsymmetrically thickened at that point by the joint. This eccentricity undoubtedly made the average stress on the joint at failure less than it would otherwise have been, and so the values obtained were less than the actual tensile strength of the metal. The effective eccentricity was not as great as one-half of the excess thickness of the joint, because the ends of the specimen were restrained. No attempt has been made to allow for the effect of this eccentric loading, because it represents a condition inherent in any so-called single-V weld which has an excess thickness.

Second, each of the four specimens had, within its tested length, several transverse welded joints. The strength of each specimen, therefore, represents the strength of the weakest of these seven joints, and so the value given, 28,500 lb. per sq. in., is less than the average strength for all joints.

Relative strength of electrically welded and riveted joints. The tension tests indicated that the resistance to tension applied with a large eccentricity is greater for the riveted joint than for the welded joint. The shear test indicated that the resistance to shear per linear inch of joint is greater for the welded joint. Measurements to determine the elastic and permanent protrusion of the container heads showed that for the two specimens so tested the welded container withstood a somewhat greater pressure without permanent distortion. In the case of the riveted containers, leakage occurred at the head joints under moderate pressures. In the case of the electrically welded containers there was no leakage at the head joint under any pressure.

Efficiency of electrically welded joints. While it is customary to speak of the efficiency of a joint, whether welded or riveted, meaning the ratio of the strength of joint to strength of plates joined, the writer does not believe that this ratio is especially significant in the case of electrically welded joints nor that any generally applicable value can be given.

It is apparent that while the strength of the plates joined is dependent solely on the physical properties of the base metal, the strength of the weld is in great measure dependent on the properties of the filling metal. Furthermore, the per cent excess thickness of the weld, which influences its strength, varies with the thickness of the plates. Accordingly the efficiency of a weld depends on the properties of the base metal, the filling metal, and the thickness of the plates.

The writer believes that the correct method of computing the efficiency of an electrically welded joint is on the basis of a specified minimum strength of base metal, a specified minimum excess thickness of weld and an experimentally determined average (per sq. in.) of the metal, of which the finished weld is composed.

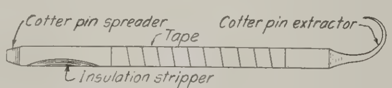
* From a paper presented by Asst. Prof. R. J. Roark, University of Wisconsin before the American Society of Mechanical Engineers, at Atlanta, Ga.

Sweden's total supply of water power, estimated at approximately 7,000,000 horsepower, is available during about nine months of the year and is exceeded, among European countries, only by Norway, which has an estimated available supply of 7,500,000 horsepower. Of the Swedish power available, only about 3,500,000 are worth developing at the present time; of this amount, 2,800,000 horsepower are privately owned and 700,000 are owned by the state.

THE INTERCHANGE

A Handy Tool

A very handy tool for extracting cotter pins can be made from an old file as may be seen in the illustration. The pointed end of the file is bent about in a semi-circle

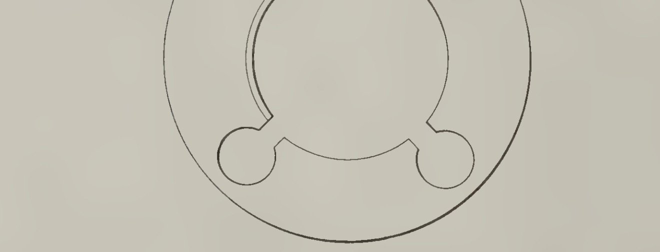


Handy Tool for Cotters

and is used as a hook to pull out cotter pins. The other end is ground as a screw driver while one edge is ground down near the end and used to scrape off insulation from wires.

A Trick in Thread Cutting

Occasionally it is desirable to cut threads with taps and dies so that bolts and nuts may turn very freely. This result may be accomplished when tapping a hole by placing a piece of tin over the tap so as to cover about half of its surface. The tin pushes the tap to one side of the hole



Tap and Die Showing How Tin Is Placed to Cut Deeper Threads

which is drilled somewhat larger than would be needed were a loose fitting thread not desired. The tin will not be cut by the tap but will turn with it.

In like manner a piece of tin may be inserted inside of a die when cutting a thread on a rod smaller than would be considered standard for the particular die.

In each case the tin forces the cutting edges of the tap or die deeper into the work and threads of proper depth may be cut.

Play the Game

It's all in the game, I tell you,
Whether you shovel or bat,
Or wipe the works of the engine,
Or pin your man to the mat:
You must play the best that's in you,
And land on the horse-hide pill;
For no one's knocked a home run yet
Who didn't swing with a will.

You see 'em lag by the roadside;
You hear 'em grumble and wheeze,
You find they shirk the hardest work,
And call the foreman "a cheese."
But the guy that rips the cover—
The fellow that oils the mill—
Is one with a home-run wallop,
Who swats the ball with a will.

So remember what I tell you—
Just think you're playin' ball;
The game's a railroad record,
And the pennant's free for all.
Up and soak the pellet squarely!
Make each moment count, until
You hit a homer every day
With the work of brawn and will.

Can You Beat It?

The following amusing incident occurred at the Information Bureau, Grand Central Terminal, the other day:

Prospective Passenger: "Give me a time table."

Information Clerk: "Where to, Madam?"

Prospective Passenger: "I only want a time table."

Inf. Clerk: "New York Central or New York, New Haven and Hartford?"

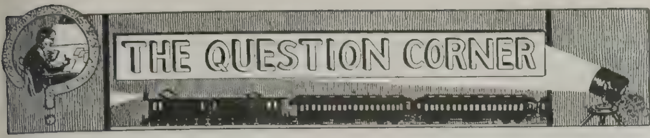
Prosp. Pass.: "New York Central."

Inf. Clerk: "What city?"

Prosp. Pass.: "South Norwalk, Conn., but I didn't think it necessary to give my life's history simply to get a time table."

Inf. Clerk (Sotto voce): "Can you beat it?"

The only influence worth having is the influence you yourself create.

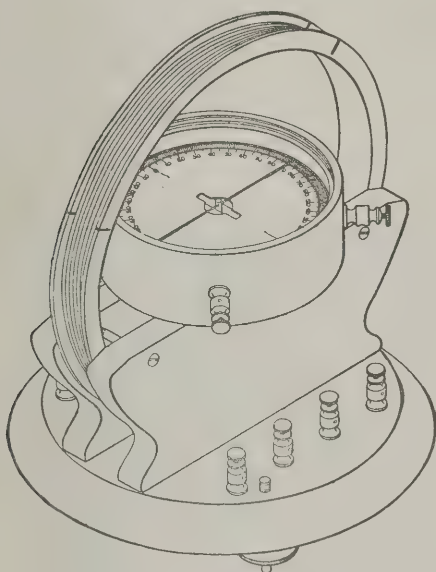


Answers to August's Questions

1. *What is the principle of a tangent galvanometer and does it read accurately?*
2. *What makes a pointer on a small d. c. ammeter stop quickly instead of oscillating before coming to rest?*
3. *Why is it that a Weston d. c. ammeter or voltmeter will not work on an alternating current circuit?*

C. R. E.

1. A tangent galvanometer is made by pivoting a short magnetic needle in the center of large circular coil held in a vertical position. The needle must be relatively short as compared with the diameter of the coil, usually not more than one-eighth of the coil diameter. Such a needle is too short to be used to indicate the angular deflection accurately and is therefore supplemented by mounting a long aluminum pointer upon the needle at right angles to it. The scale over which the pointer plays is graduated in degrees.


One Type of Tangent Galvanometer

In using a tangent galvanometer the instrument is placed so that the plane of the coil is parallel to the magnetic field of the earth. With the coil in this position and no current flowing through it, the pointer should rest at zero on the scale. When current is caused to flow in the coil there will be a magnetic field set up through the center of the coil. This field combines with the earth's magnetic field and the resultant field determines the position at which the pointer will come to rest, or the extent of the angular deflection. In a tangent galvanometer the strength of the current is not directly proportional to the deflection produced but is proportional to the tangent of the angle of deflection—hence the name tangent galvanometer.

When using the galvanometer, it is necessary to note the number of degrees of deflection and then from a table of tangents, ascertain the tangent of the angle of deflection. This tangent will give the relative value of current intensity required to produce the deflection noted. A known current producing a definite deflection is essential in order to determine the value of unknown currents. Moreover, some computation is needed. The following formula is used:

$$\frac{c}{c_1} = \frac{\tan d}{\tan d_1}$$

where c is the known current; d, the deflection in degrees for the known current; c_1, the unknown current; and d_1, the deflection for the unknown current. For example, suppose a certain tangent galvanometer gave a deflection of 23 degrees with a current of 5 amperes flowing through the coil. What would be the value of the current when the deflection was 34 degrees?

Using the formula and substituting the proper values from the table of tangents, we have,

$$\frac{c}{c_1} = \frac{.4245}{.6745} = \frac{5}{c_1} = \frac{.4245}{.6745} = c_1 = \frac{5 \times .6745}{.4245} = 7.94 \text{ amps}$$

Tangent galvanometers are usually too bulky to be used very much outside of laboratories. A well-designed and carefully made tangent galvanometer may be considered as reliable and accurate but on account of the computation required and the fact that the instrument is not suitable for carrying about, it is but little used in general practice.

2. Not all pointers of ammeters and voltmeters do come immediately to rest but those that do are designed on the "dead beat" principle. A fundamental feature of such instruments is the rotating copper bobbin which supports the coil. Current passing through the coil sets up a magnetic field which reacts upon the strong field of a permanent magnet and causes the bobbin to rotate. As the bobbin moves through the magnetic field, eddy currents are set up in it which tend to oppose its motion and cause it to come to rest very quickly.

3. Some instruments are so designed that they will operate equally well on alternating or direct current but the Weston d. c. ammeters and voltmeters being constructed on the D'Arsonval principle, require the action of one magnetic field upon another for their operation. These two magnetic fields are of necessity fixed in direction. If one of the fields were alternating in character as would be the case when the instrument was connected to an alternating current circuit, there would be no continuous torque to produce the movement of the pointer in one direction.

Questions for September

1. *I frequently want to know how much electrolyte there is in a car lighting battery which is in such a position that I can't see into the vent hole. With a bit of stick or a piece of broken separator, I can usually tell whether the electrolyte is covering the plates or not, but isn't there a better way of telling just how much there is? Is there any way of telling how much sediment there is in the bottom of a cell without taking the cell apart?*—P. T. B.

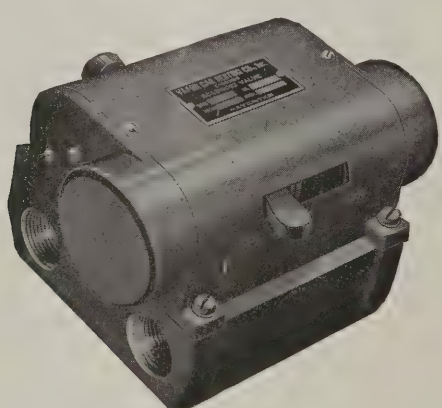
2. *When a motor is to be used to drive a machine tool, there is often a question as what kind of drive to use, belt or gear. Can you tell me something about the limitations of the two kinds of drive with reference to horsepower and motor speed?*—L. M. S.

NEW DEVICES

Double Automatic Control Vapor Heating System for Passenger Cars

The Vapor Car Heating Company, Inc., Chicago, has recently marketed a double automatic control vapor system, the purpose of which is to change from a constant temperature of 70 deg. while the car is in service to 50 deg. in yards and terminals without manually operating the cut-out valves.

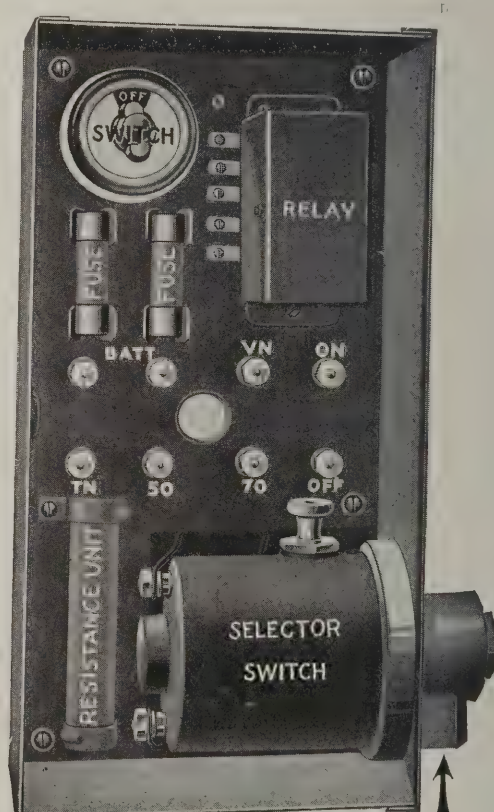
On the average, passenger cars lay over in yards or terminals two-thirds of the time, and during such layover periods are excessively heated as the result of leaving all the heat turned on to prevent freezing of water pipes and to permit of washing and cleaning the cars. By automatically regulating the temperature to 50 deg. in cars laying over in the yards steam is used in the heating pipes less than one-fourth of the time. This means a large saving in coal consumption, conservatively estimated on the basis of actual tests to average from 15 to 20 tons per car per season.



Electro-Pneumatically Operated Control Valve

The new arrangement may readily be applied to cars already equipped with the "Vapor" system, as the only change involved is the substitution of the automatically operated cut-out valves in place of the present hand-operated valves. In the case of an ordinary coach, chair or dining car, instead of the two hand-operated Vapor cut-out valves now used, one magnetically operated control valve is used on each side of car. This valve operates on the same short-circuit self-drawing principle as the manually operated Vapor cut-out valve, and therefore serves constantly to keep the outlet of the system warm at all times, positively preventing freezing of the system.

In addition to the magnetically operated control or cut-out valves, there is one double thermostat located at the center of the car near the basket rack. One of the elements of this thermostat is set for a permanent temperature of 70 deg. and the other for 50 deg. The thermostats never require adjustment or change. At the end of the car, near the electric light switchboard, is a control cabinet, which contains a combination air-pressure and electric device which automatically selects either the 70 deg. or the 50 deg. thermostat. When the car is attached to a locomotive for passenger service, the pres-



Control Cabinet Containing Electro-pneumatic Selector Apparatus

sure from the air line operates this device, putting the 70 deg. thermostat in control and maintaining a temperature between 70 and 72 deg. at all times when steam is being supplied from the locomotive. When the car is removed from service and goes into the yards, the pressure on the air line is released and the combination air pressure and electric device then puts the 50 deg. thermostat in control.

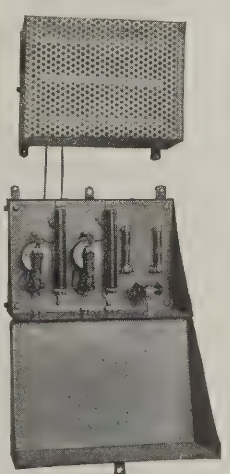
This arrangement of the control system removes the necessity for train crews or yard men to operate the steam admission valves by hand at any time.

In cases where cars are placed under steam while occupied by passengers, in stations, or at lay-over points, while waiting for the locomotive to be attached, a 70 deg. temperature control may be obtained by lifting a button provided on top of the combination air and electric device in the control cabinet. After pulling up the button for this purpose, no further attention is necessary, as the system again becomes automatic as soon as air is applied. There is a snap switch in the control cabinet to be used only to cut off current in the summer months or for repairs: In case the electric current fails the magnetic valves may be operated by hand the same as any Vapor cut-out valve.

The system is operated by electric current from the car lighting batteries and requires less than 0.1 ampere per hour, but the electrical mechanism of the cut-out valve is such that the current is automatically cut off from the magnets with the completion of the act of moving the valve from one position to the other. The electrical equipment is simple and of standard materials, and the entire system is constructed with the view of operating indefinitely at the minimum expense for maintenance.

Automatic Direct Current Motor Starter

An automatic motor starter known as type "SS" for 250 or 500-volt direct current motors, ranging in capacity from 3 to 10 h. p., is being marketed by the Automatic Reclosing Circuit Breaker Company, Columbus, Ohio. The starter is of the counter e. m. f. type with one step of resistance which is automatically cut out when the motor comes up to speed. The resistance is of such a value that it limits the starting current to the full load current of the motor and is of sufficient capacity to carry this full load current indefinitely.



Starter Complete With Panel Box Open

The starter is applicable to any direct current motor at 10 hp. or less on which the starting torque required does not exceed the full load torque of the motor, and may be used for motors driving pumps, blowers and rotating apparatus not having excessive static or starting friction, or on which the load comes on as or after the motor comes up to speed.

The starter is made in two units, one of which includes the resistance mounted and enclosed in a perforated sheet iron box and the other the starter panel, which is mounted and totally enclosed in a sheet iron box. The boxes are provided with feet for separate mounting. On the starter panel is mounted a double pole single throw knife switch, two main line fuses and two automatic contactors with graduated resistances. The double pole knife switch is operated by the handle projecting through the bottom of the panel box.

When the knife switch is closed the shunt field of the motor is energized and one of the contactors closes, connecting the starting resistance in series with the motor armature and series field across the line. When the motor comes up to speed the counter e. m. f. of the armature energizes the second contactor and it closes, shunting out the starting resistance. If the motor fails to start the first contactor only closes and the resistance and motor in series remain connected across the line. The starter is furnished for either 250 or 500 volts in capacities of 3, 5, 7½ and 10 hp.

Alternating Current Motor-Headstock Speed Lathe

The manner in which motors with the proper characteristics are used to eliminate pulleys, belts, gears and other mechanical parts is illustrated by the latest lathe development of the J. G. Blount Company, Everett, Mass. It consists of a 12-in. alternating current, motor-headstock speed lathe designed to meet the requirements of any pattern shop. This machine, which is provided with S. K. F. ball bearings, can be mounted on a bench as shown in the illustration. The headblock, consisting of a rotor and outside frame together with necessary

Blount Direct Motor-Driven Speed Lathe

windings, is supplied by the Westinghouse Electric & Manufacturing Company. The motor frame is a cylindrical iron casting with openings at the bottom to bring out the leads to the controller, which is directly beneath and totally enclosed. The end brackets are solid, thus making a fully enclosed motor. The feet are cast integral with the brackets, giving strength and rigidity to the motor. The bearings are mounted in dust-proof housings and secured to the spindle by suitable lock-nuts. The bearings are of larger size than regularly furnished

on these headblocks, and take end thrust in either direction.

The spindle is made of 45 carbon steel, carefully turned, threaded and ground, with a ⅝-in. hole bored the entire length. The nose end of the spindle is 1⅛-in. outside diameter, threaded on the end with 10 V threads per inch to receive a face-plate, chucks, or other equipment.

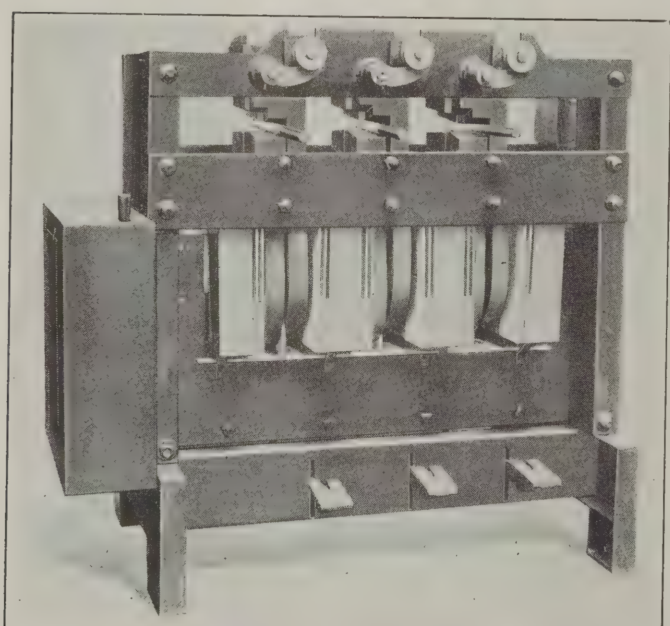
A Morse No. 2 large taper is used for the live center, and by using this particular size of taper, a much larger hole can be bored in the spindle than otherwise. The rear end of the spindle has the same size of thread as the nose end. An outside face-plate and pulley combined, 8 in. in diameter, completes this unit.

The distance between centers is 25, 37 and 49 in. on the 4-ft., 5-ft. and 6-ft. beds respectively. The portion of the bed under the headstock is widened out to allow for the controller thus fully enclosing it. A hand wheel gives four spindle speeds of 575, 1,160, 1,750 and 3,450 r.p.m. respectively. Each lathe is provided with one spur and cup center, three T-rests, a 5½-in. faceplate, a 3-in. screw chuck and a 2½-in. by 4-in. right angled rest.

Two-Path Electric Heater

Various forging operations demand the heating of material in some cases on the ends, and in other cases at points along the length of the material some distance from the ends, this heating to be accomplished without burning or melting the metal at any point.

The Berwick two-path electric heater, illustrated, has been developed for the above purpose by the American



Berwick No. 3 Two-Path Electric Heater

Car & Foundry Company, New York. Two separate electrodes are provided, each properly insulated from the other. The right-hand electrode has at its two upper ends projecting blocks which overhang but are not allowed to touch the left-hand one. The left-hand electrode is stationary, so far as vertical motion is concerned, but may be adjusted horizontally by means of two stud bolts on the rear of the heater.

The top, or right-hand electrode, is arranged so that it may be adjusted horizontally and at the same time be moved in a vertical direction. Horizontal motion is provided by sliding the electrode clamping device along the shaft provided for the purpose, while vertical motion is imparted to the electrode by depression of the pedal, thus causing rotation of the shaft, which in turn, through cams, raises the shaft carrying the electrode. The material to be heated is inserted between the top and bottom electrodes, and due to the double path the time of heating is reduced and the possibility of pitting is not so great.

Flexibility of the rear portion of the bottom electrode is provided by a spring on the rear of the heater, the top face of the electrode being set on an incline so that when the top electrode is dropped into position, contact is assured at four points on the material.

This machine may be built in any number of electrodes up to five. To date single, double and triple electrode machines have been built, while machines carrying more electrodes are in the process of manufacture. As the heaters are now designed, stock can be heated from 1 in. to 8 in. long or from 3 in. to 11 in. With a slight change from the standard heater, this length could be increased to 16 in. or 18 in. For high production on the No. 3 type heater, the stock should be from ⅜ in. to ⅞ in. in diameter. To get a high hourly production, in heating ⅞-in. and 1⅛-in. stock, it is advisable to use the No. 4 type heater. The time of heating is greatly reduced by the use of the two-path method and since the current has four points of entrance rather than two, there is no marring of the stock.

Tests on the Berwick No. 3 two-path heater have been made, the data shown in the accompanying tables being submitted as the results of these tests.

It will be noticed that in some instances the heaters were operated on 440 volts and in other cases on 220 volts. In figuring out the capacity of a heater, it is better to obtain the hourly capacity on a single electrode and then provide the heater with a sufficient number of electrodes to give the desired hourly heats. On these test figures the range of work is from 1⅛ in. to 7 in. long.

TABLE I—TEST DATA SECURED WITH NO. 3 ONE-ELECTRODE, TWO-PATH HEATER

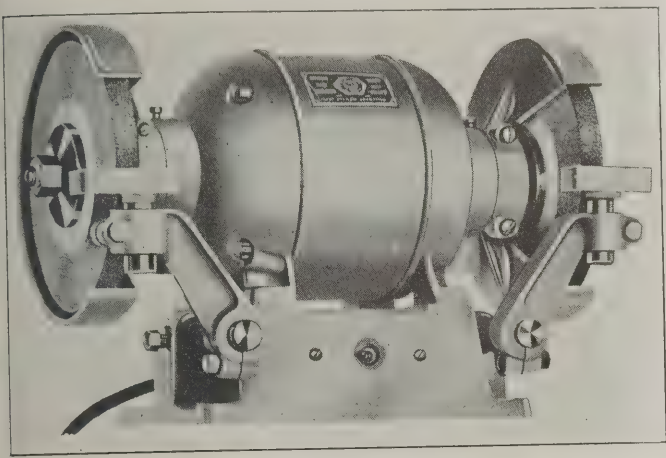
Size of Material	Taps	Length of heat	Pieces per hour	Pounds per hour	Kw. hrs. per 100 lb.	Volts	Peak Amperes	Peak kilowatt
⅜ in. rod	180	4½ in.	216	30.5	13.4	445	17	7.5
½ in. rod	180	4½ in.	144	36.0	18.0	450	28	12.5
⅝ in. rod	180	4½ in.	120	46.4	18.1	440	34	15.
¾ in. rod	180	4½ in.	96	54.0	19.5	440	34	15.
⅞ in. rod	180	4½ in.	75	63.0	20.0	440	35	15.25
1 in. rod	180	4½ in.	60	60.0	23.6	440	35	15.
1 in square	180	4½ in.	54	69.0	22,2	440	35	15.
2 in. by ½ in.	210	4½ in.	30	38.2	27.6	440	27	12.
3 in. my ⅜ in.	240	4½ in.	16	23.0	36.8	435	21	9.
½ in. rod	90	6½ in.	68	24.5	19.8	226	45	10.5
⅝ in. rod	90	6½ in.	56	31.5	20.8	226	57	13.
¾ in. rod	90	6½ in.	50	40.6	21.0	224	60	13.
⅞ in. rod	90	6½ in.	48	53.0	21.6	224	60	13.
1 in. rod	90	6½ in.	34	49.3	22.2	222	61	13.5
1 in. square	90	6½ in.	30	55.2	20.8	222	65	14.5
2 in. by ¼ in.	90	6½ in.	39	36.0	26.6	226	63	14.
2 in. by ½ in.	90	7 in.	30	55.2	24.7	230	67	16.
3 in. by ⅜ in.	90	7 in.	27	60.2	22.7	228	70	16.
1 in. pipe standard.	210	4½ in.	84	49.9	21.1	445	28	12.5
1 in. pipe standard.	180	7 in.	60	55.5	16.0	440	33	14.5
1½ in. pipe standard	210	4½ in.	60	42.2	22.7	440	28	12.5
1½ in. pipe standard	180	7 in.	42	45.9	25.6	440	33	14.5

TABLE II—TEST DATA SECURED WITH NO. 3 THREE-ELECTRODE, TWO-PATH HEATER

Tap	Size	Heats per Hour	Kw. hrs. per 100 lb.	Volts	Amperes	Average Kilowatts	Peak Kilowatts
120	½ in. by 2½ in.	516	20.0	224	58	13	18
120	⅜ in. by 2 in.	648	23.5	224	45	10	16
135	½ in. by 2¼ in.	372	24.7	226	44	10	13
135	⅜ in. by 1⅞ in.	564	23.9	224	33	7.5	11

New Electrical Grinder

A new grinder, with two wheels mounted on the same shaft with the armature of an electric motor, has been placed on the market recently by the Black & Decker Mfg. Co., Baltimore, Md. The motor is not universal, but may be furnished for either direct or alternating current at 110 or 220 volts, and if for alternating current in either 40 or 60 cycle. A toggle switch, easily operated by a throw to the left or right, is mounted in the base of the machine.

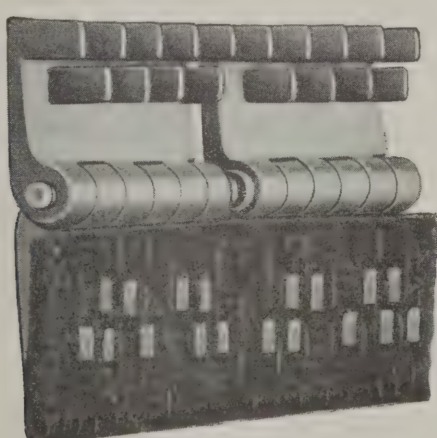


A Two-Wheel Bench Grinder

The wheels are 8 in. in diameter and ¾ in. face, operating at a no load speed of 3,600 r. p. m. Each wheel is supplied with a wheel guard covering three-fourths of the periphery. Tool rests, adjustable in two directions, assist in grinding various tools or parts. The machine, which weighs 75 lb., may be mounted on a work bench or a special cast-iron pedestal can be furnished if desired.

Car Lighting Belt Fastener

A new type of belt fastener for car lighting belts has been developed by the Main Belting Company for which much is claimed and which has met with the approval of a number of railroad men who have tried it.



The Main Belt Fastener

The fastener is a hinged malleable iron casting having teeth integral with its back. The under surface of the plate is curved to conform to the perimeter of the generator pulley. The teeth are so designed and spaced as to give maximum holding power, displacing the fabric of the belting rather than cutting it, and leaving a minimum amount of metal on the pulley face of the belt. The casting and pin are so treated that the moving parts are as hard as the wearing parts of a sewing machine while the teeth are malleable.

The fastener is used in pairs spaced ¼ in. apart which permits the belt to flex and properly conform to the highly crowned pulleys characteristic of the service.

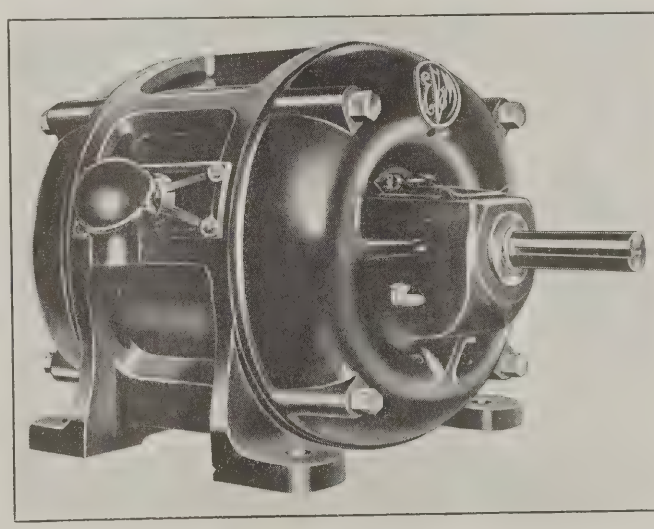
The claims for the fastener made by the manufacturer are: great holding power, reduced cracking of the belt back of the hook, ease of application, no extra clearance required and minimum wear of moving parts.

A New Line of Induction Motors

The Electric Controller & Manufacturing Company of Cleveland, Ohio, are putting on the market a squirrel-cage induction motor. New ideas have been introduced in the design.

It is claimed that this motor is unusually well constructed, not only from a mechanical standpoint but from the standpoint of efficiency, power-factor and torque. No filing or fitting is allowable in the manufacture of the motor, but it is so carefully built mechanically that the various parts must fit or be rejected.

The stator frame is cast around the stator laminations, thus insuring perfect rigidity and alinement. The shrinkage of the frame after pouring puts the laminations under heavy pressure and removes any possibility of the motor becoming noisy. The frame is of the skeleton type so that the major portion of the stator laminations is exposed to the air. Fan blades are used on only a few of the 900 r. p. m. motors. The 1200 and 1800 r. p. m. motors do not have fan blades as most of the cooling is done by direct contact of the laminations with the air.



One of the New Type Motors

The stator windings are all impregnated twice; once, after the coils are wound, and again after the stator is completely assembled and wired. All coils are form-wound, and open-slot construction is used.

The same care is used in the manufacture of all of these stators that is ordinarily used only when severe moisture or oil paper conditions are to be met.

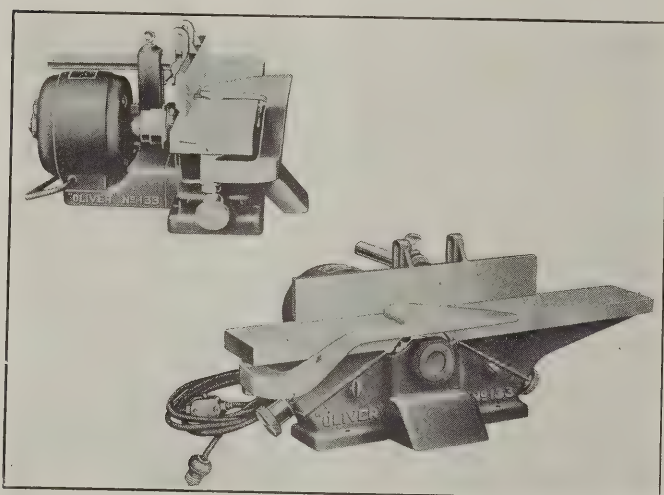
The bearings are extra large and each bearing is provided with two oil rings, one of which is sufficient to properly lubricate the bearing. The extra ring is used as a factor of safety. The oil wells are larger than is ordinarily used so as to give further protection against hot bearings.

The rotor has cast end rings and the shaft is made much larger than standard engineering practice demands.

The new line of motors will be supplied for 110, 220, 440 and 550 volts, on two and three phase circuits.

Portable Hand Planer and Jointer

Two views of the portable hand planer and jointer recently placed on the market by the Oliver Machinery Company, Grand Rapids, Mich., are shown in the illustration. This machine has been designed to meet the demand for a portable, compact, motor-driven hand planer and jointer to replace the hand plane for jointing and fitting almost all classes of small work in wood construction. The machine is said to be thoroughly accurate and efficient, being fitted with ball bearings and arranged to run from any electric light socket or power circuit. The arrangements for safe-guarding are plainly shown in the illustration. The machine has a capacity to plane work 6¼ in. wide on the 6 in. machine and 4¼ in. wide on the 4 in. machine. Both sizes rabbet up to ½ in.



Oliver Portable Hand Planer and Jointer

The tables are mounted on inclined dove-tailed ways, being raised and lowered by means of a hand-wheel and screw and being easily locked firmly in any position. Each table has a steel lip next to the throat opening. The fence can be quickly adjusted anywhere across the tables, also tilted and locked to any position up to 45 deg. It is 16 in. long, 2½ in. high and when not in use may be shoved back out of the way of the knife jointing and setting attachment. The cutter head is the three knife, circular, safety type, fitted with three tungsten-chromium thin steel knives which are ⅛ in. thick and 1 in. wide. The cutting diameter is 3½ in.

The motor is direct-connected by means of a universal flexible coupling. It is fully enclosed, and fitted with ball bearings, being designed to run at 3,600 r.p.m. A ¼-h.p. motor for the 4-in. machine and a ⅓-h.p. motor for the 6-in. machine are required. The knife setting attachment is furnished when desired. It consists of a right angle way with a slide block, jointing stone and aluminum guard. It serves as a guide for setting the knives and by sliding the jointing stone back and forth while the cutter head revolves it will sharpen and join the knives so that all three knives will cut equally.

Combination Insulating and Friction Tape

A new kind of tape which combines in one product the properties of both rubber and friction tape is being marketed by the Diamond Holfast Rubber Company, Atlanta, Ga. The new product is sold under the trade name of "2 Plex" Diamond Holfast Insulating Tape.

The body of the tape is cotton, saturated and finished with black compound. On one side is placed the insulating compound layer. This insulating compound is red in color and of tough, closely adhering, elastic texture, but which does not stick to the fingers. The manufacturers claim that the tape takes the place of both friction and rubber tape otherwise required and is suitable for general use.

The tape is made ¾ in. wide and put up in half pound rolls, wrapped in tinfoil for preservation.

Power Drive for Die Stock

The machine illustrated has been developed recently by the Toledo Pipe Threading Machine Company, Toledo, Ohio, for this purpose, namely to provide power drive for the hand pipe-threading devices which are made by that company.

Tests indicate that this device has great time- and laboring-saving possibilities, it being possible to cut a 2-in. thread in 18 seconds, a 4-in. thread in 2 min., a 6-in. thread in 3 min. or a 12-in. thread (including the time necessary to run over the pipe with a set of blank dies to true up the surface) in less than 15 min. These are said to be actual working figures which can be reproduced regularly on any pipe-threading job.


Toledo Power Driving Unit and Head Cutting 4-In. Pipe Thread

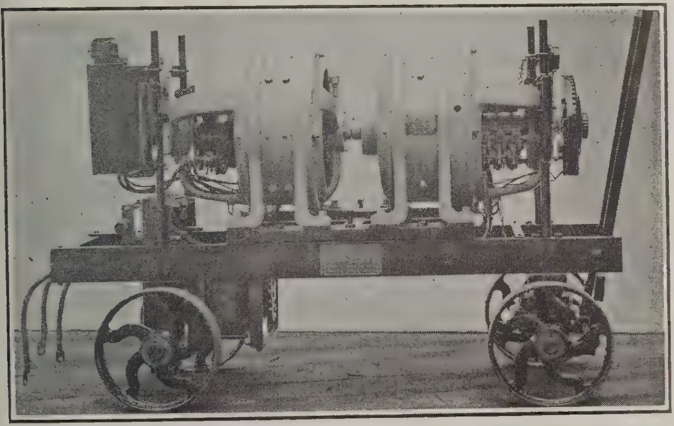
The device consists of an especially designed electric motor mounted in a housing that also encloses transmission gearing, communicating to a driving shaft, extending to the operating end of the shaft housing, the whole mechanism being mounted on wheels thus providing for easy movement from place to place. Mounted on the shaft housing just above the motor is a fuse box containing two especially designed fuse plugs which will permit of normal loads but blow should any overload become dangerous to the life of the motor. Mounted midway on the shaft housing is a switch box to which the flexible cable is connected by a two pole plug.

The driving head is furnished with two bushings, one containing a cored hole 15/16 in. square and the other containing a cored hole 1 1/16 in. square, these holes being supplied to fit the two sizes of pinions used on the various Toledo tools. At slow speed the driving head rotates at 38 r.p.m. and on high speeds at 57 r.p.m.

A Large Capacity Welding Set

A portable welding outfit of increased capacity is being manufactured by the U. S. Light & Heat Corporation, Niagara Falls, N. Y. It consists of a motor-generator set and control apparatus mounted on a four-wheel hand truck.

The generator has a continuous capacity of 300 am-



The 350-Ampere U. S. L. Welding Set

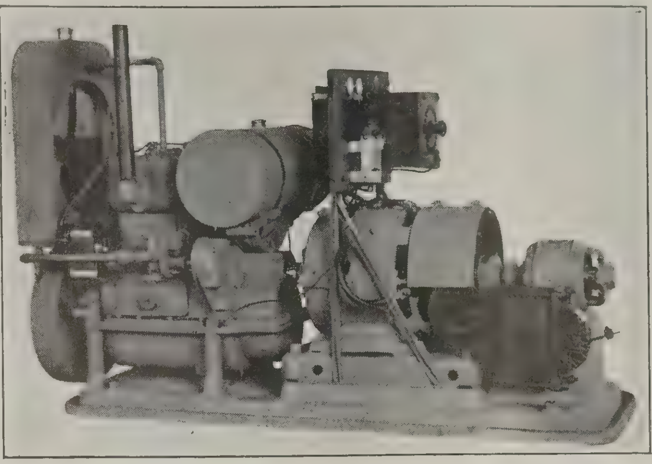
peres, and for cutting and other work of an intermittent nature will develop 400 amperes. It is designed with inherent regulation and has the same characteristics as the 200-ampere machine made by the same company. The generator is also furnished for belt or gas engine drive.

The set is supplied with either a direct or alternating current motor and weighs complete about 1,700 lb.

Electric Welder with Gas Engine Drive

A compact outfit for electric arc welding, consisting of a gas engine, a welding generator, and control panel, has been developed by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. This outfit should be adaptable for use on maintenance of way trains or for use in any place where it is desirable to employ arc welding or cutting, and where electric power is not available.

The gasoline engine is a 2-cylinder, slow-speed, marine type, and the outfit is completely self-contained, the engine and generator equipment being mounted on a substantial bedplate, together with the oil and gasoline tanks and a radiator for cooling the engine. Forced feed lubrication



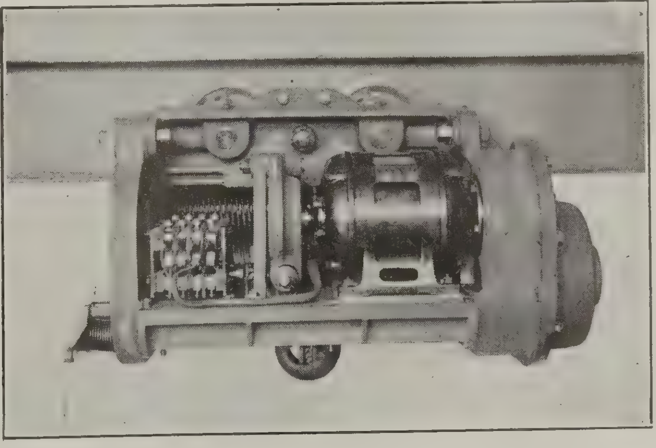
A Self-Contained Gas Engine-Driven Electric Welding Outfit

is used, making it unnecessary to level the machine before placing it in operation.

Electric Hoist with Short Headroom

The principal feature of a new hoist developed by the Standard Electric Crane & Hoist Company, Philadelphia, Pa., is the short headroom required for its operation. The three-ton hoist can be operated with a headroom as low as 14 in., this dimension being considerably less than needed for the usual electric or chain hoist.

The new standard hoist is of simple and rugged design, being entirely enclosed as a protection against dust and



Standard Electric Hoist With Cover Plate Removed

weather. A straight spur gear drive is used throughout. All gears and main bearings operate in an oil bath, other bearings being lubricated by the Alemite high pressure system. The arrangement of the hoisting motor, holding brake and controller are shown in the illustration. The hoist is equipped throughout with high-duty Hyatt bearings and an efficiency of over 80 per cent is said to be obtained with a standard stock hoist. All track wheel pins are made of manganese axle steel.

General News Section

Scheid Engineering Corporation, 90 West St., New York City, has been appointed metropolitan and export representatives for the Franklin Moore Company, Winsted, Connecticut, manufacturers of material handling machinery for industrial plants.

Recently the Northwestern Region of the Pennsylvania issued the first number of its "Pennsylvania News." It is an eight-page tabloid size newspaper, four columns to the page. It will be published every two weeks and distributed to each of the 18,500 employees of that region.

The Wilson Welder & Metals Company, Inc., 132 King street, New York City, recently appointed the King-Knight Company, Underwood building, San Francisco, Cal., exclusive representatives in central and northern California for Wilson plastic-arc welding machines and Wilson Color-Tipt metals.

The St. Gotthard line in Switzerland is now completely electrified for both freight and passenger service. The line extends from Lucerne to Chiasso on the Italian border, a distance of about 180 miles. Grades of 2.5 per cent are common and there are many tunnels, the longest of which is 9¼ miles.

Completion of the electric operation of the Rhatian Railways in Switzerland was celebrated in May of this year.

Electrification of the Harbor Railway Terminals in Montreal, Quebec, with a total trackage of 58 miles, is proceeding, and it is expected that by the end of September 42 miles will have been electrified. The remaining 16 miles will probably be completed next season, according to a statement issued by M. P. Fennell, manager of the Montreal Harbor Commission. Electric locomotives of a type especially suited for harbor work will be purchased by the Commission.

Automobile drivers are actually becoming more careful. This is the conclusion of the Safety Department of the Southern Railway from a check at three crossings on the Dixie Highway in Kentucky. The checkers found:

Number of vehicles passing over crossings	967
Number stopped before crossing tracks	221
Number where driver looked in one direction	354
Number where driver looked in both directions	555
Number where driver crossed without taking any precautions	58
Number crossed at speed exceeding twenty miles per hour	28

This check discloses that one driver out of every four actually stopped to make sure that no trains were approaching and 57 per cent looked in both directions. Only 6 per cent crossed without taking any precaution whatever.

Changes in personnel affecting several departments of the Westinghouse Electric & Manufacturing Company have been announced by officials of that company. M. C. Rypinski has resigned his position as head of the radio sales division to become vice-president of C. Brandes, Incorporated, of New York City, manufacturers of head telephones. George Bailey, supervisor of distributing agents, will have charge of the work formerly cared for by Mr. Rypinski. C. R. Gilliland has been appointed manager of the Indianapolis office. In the Cincinnati office, C. L. Barton has been appointed manager of the central station division; F. H. Nealis has been appointed manager of the merchandising division, and L. P. Morris has been appointed manager of the transportation division. W. A. Munson has been transferred from the service department to become office manager of the Pittsburgh district. A. R. Sterner has been transferred from the Pittsburgh office to the Columbus sub-office as chief correspondent and engineer.

Lighting Equipment of New Burlington Passenger Cars

The Chicago, Burlington & Quincy has received 20 of the cars recently ordered for passenger service. Fifty-four of these cars were ordered from the Standard Steel Car Company, Hammond, Ind. Of this order, 22 are mail cars for the C. B. & Q., five of them being equipped with the axle-light system and 17 for the standard head-end lighting system. The axle-light equipped baggage cars are 13 in number, five of them for the Colorado & Southern, four for the Ft. Worth & Denver City and four for the C. B. & Q. Out of 19 combination baggage and mail cars, ten are equipped with head-end system to be used on the C. B. & Q. Of the other nine which are equipped for axle-light, five will be used on the C. & S. and four on the F. W. & D. C.

The Pullman Company received orders for 74 cars including 54 coaches, five chair, two combination coach and chair, one combination passenger and baggage and 12 diners. Ten of the coaches and ten diners have been delivered. Of the 42 coaches for the C. B. & Q. on this order, 13 are axle lighted and 29 are for the head-end system. There are six coaches axle equipped for each of the C. & S. and the F. W. & D. C. The five chair-cars and the two combination coach and chair cars are axle light equipped for use on the C. B. & Q. The one combination passenger and baggage car is head-end equipped for the C. B. & Q., as are ten of the diners. The two remaining diners are axle lighted, one to be used on the C. & S. and the other on the F. W. & D. C.

General Electric Company to Build New Plant

It was recently announced by Dr. Thomas Addison, district manager of the General Electric Co., that the company intends to begin at once the erection of a second plant at Oakland, Calif., part of which will be devoted to increased facilities for the manufacture of switchboards and the remainder occupied by meter and instrument laboratories, service shops and offices.

The tract where the new plant will be erected comprises 24 acres. The building is to be of steel, brick and concrete, and will embody all of the best features of modern factory construction. It will be a model of illuminating engineering and will be completely wired and equipped throughout with the latest development in electrical machinery. This project represents an investment of $200,000.

The Pacific Coast offices of the company will be maintained in San Francisco, but the present switchboard plant and service shop now located in San Francisco will be transferred to the new Oakland plant.

The greater facilities afforded by the new plant and special connections with the Western Pacific and Southern Pacific railroads will enable these branches of the General Electric organization to render the Pacific Coast electrical industry excellent service.

One type of work that will be carried on in the new plant is exemplified by the great switchboard now being constructed for the Don Pedro power plant of the Turlock and Modesto Irrigation District. This switchboard has a capacity of 15,000 kw. and will control the three 7,500-hp. generators, as well as the large transformers which are used in connection with them.

Electric Trains May Be Run Over M. K. & T. Line

A contract is now in process of negotiation between the Missouri, Kansas & Texas and electric power interests which if consummated will furnish electric passenger service between Dallas and Denton, Texas, a distance of 48 miles.

It is proposed that the electrical interests shall lease the trackage rights and that electrification of the line will in no way interfere with the operation of freight trains on the line, nor with the operation of through passenger trains. Z. G. Hopkins, manager, Department of Public Relations, M., K. & T., states that at the present time no change is contemplated in the operation of M., K. & T. trains.

C. E. Calder, president of the Texas Power and Light Company and of the Dallas Power and Light Company, stated that a contract with the railroad for electrification would comply with an agreement made with the city of Dallas for the construction of an interurban line at least 30 miles in length which the Dallas Railway is under bond to build in order to fulfill the terms of an agreement entered into in connection with the granting of the franchises to the Strickland-Hobson interests in 1917. Electrification of the M., K. & T. from Dallas to Denton, according to Mr. Calder, will be an economic proposition from the standpoint of the railroad, as well as the electrical interests.

The railroad now operates six passenger trains on this line, two of which are night trains. It is the intention of the power company to run electric trains hourly. The cost of electrifying has been estimated at between $800,000 and $1,000,000.

New Electric Locomotives for the Norfolk & Western

The Norfolk & Western has ordered through Gibbs & Hill, New York City, from the American Locomotive Company, four double-unit electric locomotives. These locomotives will have a total weight in working order of 750,000 lb.

Personals

Harry B. Ennis has been recently appointed field representative in the Metropolitan district of the Bryant Electric Company. Mr. Ennis was connected with the Brooklyn Edison Company for seven years, during which time he served in a sales capacity with the New Business Department. His experience there covered the procuring of house and store wiring contracts and the supervision of the installations which involved contact with many of the local contractor-dealers in Brooklyn. Several years was spent in selling electric apparatus, among which were ornamental street lighting standards, electric signs, electric trucks and all kinds of household appliances. After leaving the Brooklyn Edison Company he was for three years associated with the Duplex Lighting Works of the General Electric Company as Illuminating Engineer. During 1921 and up to July, 1922, he represented the H. S. Whiting Company as sales engineer in the Metropolitan district. Mr. Ennis began his new duties on July 1, by spending several days at the factory in Bridgeport, Conn., where he made a close study of the routine work and concentrated on the various manufacturing processes.

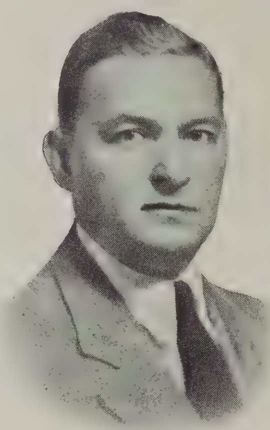
H. B. Ennis

Frank B. Chapman has been appointed eastern sales manager of the Bryant Electric Company, succeeding George V. W. Ingham, who has resigned. Mr. Chapman will make his headquarters at the factory in Bridgeport. His experience embraces nearly 30 years devoted to the electrical industry. In the early nineties he was connected with the Utica Electrical Manufacturing Company of Utica, N. Y. This was the construction department of the Utica Light & Power Company. When the department was abandoned Mr. Chapman with two other foremen incorporated the B. & C. Electric Construction Company of Utica, doing general construction work not only in Utica, but in parts of the South, where they installed electrical equipment in a number of cotton mills. After five years Mr. Chapman disposed of his interest and affiliated himself with the Roller-Smith Company as a sales-

F. B. Chapman

man of precision instruments, circuit breakers, etc. Two years later he resigned to accept a position as field representative with the National Carbon Company. In November, 1922, Mr. Chapman resigned from the National Carbon Company and since that time has been field representative for the Bryant Electric Company in the Middle Atlantic and Southern States.

H. A. Matthews, sales manager of the railway division of the U. S. Light & Heat Corporation, Niagara Falls, N. Y., has been elected a vice-president. He will still continue to have charge of sales in the railway division, his full title now being vice-president, sales, railway division. Mr. Matthews entered the railway supply business in 1912 with the U. S. Light & Heat Corporation at Chicago. Prior to that time he had been employed by the Lake Shore & Michigan Southern as clerk to the general superintendent at Cleveland, and later entered the services of the Pullman Company. For seven years he was secretary to the president of the Pullman Company, which position he held up to the time he joined the U. S. L. forces at Chicago. In 1917 he was transferred to the factory at Niagara Falls and placed in charge of the railway sales department.



H. A. Matthews

W. H. Burleson has joined the Ohio Brass Company and will give his time to sales work in the high-tension transmission department of the business. Mr. Burleson is a native of Texas and was graduated in 1913 from the Agricultural and Mechanical College of that state. Since that time he has been connected with the Texas Power & Light Company, Dallas.

H. E. Dalzell has resigned his position as chief mechanical and electrical engineer of the Southern Railway of Peru after fifteen years' service in the tropics. He is taking eight months' holiday and will take advantage of this time to place his several inventions on the market. He expects to take up an appointment on the east coast of South America in the spring.

B. F. Bardo has been appointed superintendent of electric transmission of the New York, New Haven & Hartford Railway Company, with headquarters at Cos Cob, Conn.

Trade Publications

Insulating and soldering.—A catalogue supplement describing insulating and soldering compounds and announcing the extension of that line of products has been issued by the Westinghouse Electric & Manufacturing Company. The publication is known as 5-A, Supplement No. 2.

Electric Fans for Railway Service.—"The Safety Fan" is the title of a 57-page catalogue recently issued by the Safety Car Heating & Lighting Company, 2 Rector street, New York. The catalogue decribes and illustrates the fans for railway cars which are made by the Safety Company and also describes the manner in which the fans can be used to best advantage. A cross indexed table shows at a glance which of the parts of the several fans and speed controls are interchangeable.

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., is distributing a Publication 4249-A, describing its line of insulating and soldering compounds. Some of the materials treated in the publication are baking varnishes, air-drying varnishes, insulating compounds, finishing materials, insulating glue, soldering flux, and lubricating oil.

Circuit Breakers.—The Roller-Smith Company, 233 Broadway, New York, has recently issued its bulletin No. 560, describing two new types of enclosed circuit breakers known as types E and P. The type P circuit breaker is fully enclosed and is operated by a single handle which projects out of one side of the case. The type E circuit breaker has two slots in the front of the case through which the handles of the separate circuit breakers project. Type E breakers are made as double pole circuit breakers only.

Lighting Data.—The Edison Lamp Works of the General Electric Company have recently issued three new bulletins under the following titles: Effect of Color of Walls and Ceilings on Resultant Illumination, Fundamentals of Projection, and The Lighting of Small Stores. All of the bulletins are illustrated and contain 16, 16, and 20 pages respectively. A group of color charts are included in the first bulletin, which show ceiling tints, side wall tints, dado tints, ceiling papers, side wall papers and wood finishes. With each sample of surfacing is given the percentage of light which the surface will reflect.

Direct Drive Axle Generator.—Specifications and description of a direct drive axle generator and system for the electric lighting of railway cars are contained in a 16-page bulletin published by the Products Distributing Corporation, 360 Madison avenue, New York, N. Y. The equipment described in this bulletin will be offered to the railroads by the above company and will be built by the Wagner Electric Company, St. Louis, under the E. M. Fitz patents. The booklet is profusely illustrated with photographs and line drawings and contains brief specifications and descriptions of the equipment. A blue print insert is included on which curves are shown giving the characteristics of the generator.

Electric Traction.—Progress in Steam Railway Electrification is the title of bulletin No. 44016 issued by the General Electric Company, Schenectady, N. Y. The bulletin contains 20 pages and is illustrated with photographs. It reviews some of the more important electrifications throughout the world for which the General Electric Company has supplied the apparatus, either in its entirety or in the more important parts. This includes the Baltimore & Ohio, the Paris-Orleans, the New York Central, the Great Northern, the Michigan Central, the Victorian Railways in Australia, the Canadian Northern, the Butte, Anaconda & Pacific, the Chicago, Milwaukee & St. Paul and others.

Railway Electrical Engineer

Volume 13 OCTOBER, 1922 No. 10

Progress in Electric Traction

During the past month announcements have been made of a number of purchases of electric locomotives and of decisions made bearing on electric traction programs which have been long pending. The Norfolk & Western has ordered four new electric locomotives, the Baltimore & Ohio has ordered two, the New York, New Haven & Hartford has ordered five and the Pennsylvania has announced that it will build three in its shops at Altoona. The Pennsylvania has also announced that it intends to go ahead with the work of electrifying the Altoona grade on its lines west of Altoona, Pa., and that extensive additions will be made to the Altoona shops. The Illinois Central has announced a decision to use a 1,500-volt direct current system for its Chicago suburban electrification and the Long Island will elevate and four-track two miles of its electrified line and will four-track two miles farther, beside making improvements and extensions to power plants and feeders.

Electric traction has been in a condition of arrested development for several years and these announcements apparently indicate that the condition is passing. The reasons for the change are fundamental. There is unquestionably a need for such facilities as are afforded by electric traction, agreements ending strikes have been made and the railroads are slowly but surely improving their financial status to the point where a few can forget their hand-to-mouth method of existence and consider the making of much needed major improvements.

Another Foundation Block

There are two reports on heavy electric traction in this issue of the *Railway Electrical Engineer*. One of these will be presented at the annual convention of the Association of Railway Electrical Engineers to be held in Chicago, October 30 to November 3, 1922, and the other was presented at the annual convention of the American Electric Railway Association, which was held in Chicago, October 2-5, 1922. These reports are of particular value, because each is the complement of the other. There is little duplication of effort and the two taken together can be used as one large report. The two societies are to be commended for their co-operation in compiling the information contained in the reports.

There are a number of other societies also interested in the subject of heavy electric traction and it is to be hoped that some way will be found by which all of the interested societies can collaborate and do away with the greater part of the duplication of effort which has characterized their activities in the past. This question of general co-operation in the study of heavy electric traction has been taken up with the various technical societies by the A. E. R. A. with the result that the A. E. R. A. committee has felt called upon to make the following statement:

"While many of the organizations with which the matter was taken up expressed interest in the proposal, and while all agreed in the value of co-operation, it now seems evident that if such a movement is to be successful, it should be under the leadership of the steam railroads."

The greatest objection to such co-operation is probably the danger of getting all of the work into the hands of a single committee. Such a committee might then be dominated by the representatives of some interest with an axe to grind. The next most formidable stumbling block is introduced by the lack of provision, on the part of the railroads, for research work. Among the societies which have many members representing power and manufacturing companies, there are ample facilities for research. If these societies should combine, it would put the railroad association under a handicap which would not be easy to overcome.

The Railway Age has suggested that the Mechanical Division of the American Railway Association, as representative of the railroad operators, ought to collaborate with the American Railway Engineering Association, representing the railroad engineers, and arrange a program to which all of the interested societies might adhere. Such an arrangement is probably ideal. In order, however, to keep the railroad representation from being dominated by the greater number of other affiliated associations, some arrangement would have to be made permitting the steam railroads to maintain dictatorship. Quite possibly not all of the societies would agree to such dictation, but if only a part were to do so, much more would be accomplished than has been done heretofore and much duplication of work would be eliminated. Details could be investigated exhaustively.

Unfortunately, not all of the steam railroads are interested in heavy electric traction. For this reason individual railroads have in the past had to work out their own problems and for the same reason it is highly probable that the A. R. A. and the A. R. E. A. could not easily overcome their own inertia suffi-

ciently to launch a well-formed method of procedure. Eventually, they may be forced to do so, but the movement will require time and development.

Time, with increasing need for electric traction, will eventually force the conclusion, and the class of work now being done by the A. R. E. E. is the kind of development needed. It consists of building a broad foundation, of collecting and compiling all of the available data on the subject, of creating an accessible bench mark from which all new electrification projects can be launched. By doing this the A. R. E. E. is not only doing a good and needed piece of ground work, but is taking another big step toward establishing itself as an important factor in the railroad field.

Electrical Apparatus on the Increase

If there has been any doubt in the minds of electrical engineers as to the extent of the increase of elctrical equipment on the railroads, it can be pretty thoroughly dispelled by a study of the lengthy chart which accompanies the report of the Committee on Data and Information contained in this issue. It can reasonably be assumed that the electrical men are aware that there has been a very real growth in electrical appliances in the past few years but until the figures had been tabulated, as they have been in this chart, the extent of this increase could only be a matter of conjecture. While it is unfortunate that conditions during the past summer have been antagonistic to the gathering of as complete data as could be desired, there is no room for doubt concerning the remarkable increase in electrical equipment since the last report of the Data and Information Committee in 1918. The uses to which electric energy is being put on steam roads are increasing almost daily. Not only are new uses developing but those applications which first found favor are becoming more and more popular. For example, the number of new cars to be lighted by gas forms a relatively small percentage of the total new cars purchased. Car lighting by electricity has become the accepted standard. What is true of the car lighting field is likewise true in every other electrical application. Wherever electric energy has been used, it has made good and the efficiency of railroad operation has been proportionately improved.

The growth in the past few years is a certain indication of a still greater increase of electrical applications in the near future. Although the investment in electrical equipment already totals many millions of dollars, is is small compared with what it will be a few years hence.

The increase of electrical equipment is by no means a passing fad or fancy but has been effected solely upon the economic possibilities that are inherent in the flexible characteristics of electric energy. No other agent can be so readily made to serve the needs of power, light and heat.

With the increase of electrical appliances will come an increase in the responsibilities of those who are in charge of them, and with such increased responsibility will come the respect and recognition which has been so long withheld. The applications of electrical energy to railroad operations are rapidly reaching a stage which will demand the very best that any electrical engineer can give. Future growth cannot be handled perfunctorily because of the frequently recurring problems which will demand careful and wise solution.

Intelligent Use of Electrical Equipment

There never was a time when it was more obvious that the electrical men of steam roads should engage in doing some missionary work among their mechanical brothers in service. It is human nature for people to pass by those things which they do not understand and it is this factor which must be overcome in order to permit electrical equipment to have full, unrestricted sway which its economical possibilities entitle it to enjoy in railroad operation. It is not enough that electrical men understand and recognize the advantages of electrical apparatus, for in many instances the apparatus is used by others who have no conception of its characteristics and who too often have a very wrong idea of what can be reasonably expected of it.

Mechanical men are accustomed to observing the development of construction work as it progresses from step to step. They deal with that which is tangible and usually visible. If trouble develops, it can usually be seen and remedied, but with electrical equipment unfortunately, it is frequently impossible to discover trouble by observation alone. More or less elaborate testing must be resorted to and there is little doubt but that it is at this point that the average mechanical man loses interest.

Electrical men should take advantage of every opportunity to pass along any information that will be helpful to others using electrical machines, but, needless to say, it must be done in the right way. If a more general knowledge of the main characteristics of electrical machinery were possessed by the men using the machines, there is every reason to believe that the expense of maintaining such equipment would be very greatly reduced.

New Books

The Welding Encyclopædia.—Edited by L. B. Mackensie and H. S. Card, second editor, 388 pages, 550 illustrations, 6 in. by 9 in., bound in flexible imitation leather. Published by The Welding Engineer Publishing Co., 608 Dearborn St., Chicago, Ill.

A reference book on the theory, practice and application of the four autogenous welding processes. The first half of the books consists of a dictionary of all words, terms and trade names used in the welding industry. Instruction for welding operations on the most common types of repair work and their application to the various industries. Oxy-acetylene welding, electric arc welding, electric resistance welding and thermit welding are each treated and general instructions are given for the use of each process with every metal that can be welded by it. Separate chapters are included on the subjects of boiler welding, tank welding, pipe welding and rail joint welding. Another section is devoted to the rules and regulations enforced by Federal and State authorities and insurance companies on the construction, installation and operation of welding equipment. A collection of charts and tables is also included. The second edition of the Welding Encyclopedia is virtually a new book since it contains fifty per cent more text material than the first edition contained.

Michigan Avenue, Chicago

Association of Railway Electrical Engineers Thirteenth Annual Convention

October 30-November 3, Chicago

CONVENTION PROGRAM

Meeting in Red Room, 19th Floor, Hotel La Salle,
Exhibits, Grand Ball Room, 19th Floor

TUESDAY, OCTOBER 31ST

Session 10:00 A. M. to 1:00 P. M.

Address of President.
Report of Secretary-Treasurer.
Report of Auditing Committee.
Unfinished Business.
New Business.
Election of Officers.
Committee on Data and Information.

WEDNESDAY, NOVEMBER 1ST

Session 9:30 A. M. to 1:30 P. M.

Committee on Power Trucks and Tractors.
Committee on Heavy Electric Traction.
Committee on Electric Repair Shop Facilities and Equipment.
Moving Picture and Talk on Automatic Train Control.

THURSDAY, NOVEMBER 2ND

Session 9:30 A. M. to 1:30 P. M.

Committee on Illumination.
Committee on Motor Specifications.
Committee on Train Lighting.
Equipment and Practice.
Committee on Electric Welding.

FRIDAY, NOVEMBER 3RD

Session 9:30 A. M. to 12 Noon

Committee on Electric Headlights.
Sponsor Committee on Insulated Wires and Cables of "American Engineering Standards Committee."
Moving Picture showing the complete process of the manufacture of insulated wire.
Afternoons will be devoted to Inspection and Study of Electrical Appliances in Exhibit Room.

Registration

Please register and secure badges at Secretary's desk. Located in hall on the Nineteenth Floor.

Theatre and Dinner Tickets should be reserved at the time of registering.

Entertainment

Exhibits are located in Ball Room on the Nineteenth Floor and will be open from Monday evening until Friday noon.

Tuesday Evening, October 31st—Informal Reception and Dancing Party, Nineteenth Floor, Hotel La Salle Red Room, 8:30 P. M. Refreshments will be served. Admission by badges.

Wednesday Afternoon, November 1st—Ladies' Theatre Party (Blackstone Theatre, "Lightnin'"). Secure tickets at Secretary's desk, from Tuesday noon up to Wednesday noon. Tickets should be reserved at time of registering.

Wednesday Evening, November 1st—Informal Dance, Nineteenth Floor, Hotel La Salle, Red Room, 8:30 P. M. Admission by badges.

Thursday Afternoon, November 2nd—Ladies' Theatre Party, Chicago Theatre. Tickets should be reserved at time of registering.

Thursday Evening, November 2nd—Informal Dance, Red Room, Nineteenth Floor, Hotel La Salle, 8:30 P. M. Admission by badges.

Friday Evening, November 3rd—Informal Dinner-Dance, Nineteenth Floor, Hotel La Salle Ball Room, 7 P. M. Secure tickets at Secretary's desk after Wednesday noon.

Report of Committee on Motor Specifications

Recognition Given to the Importance of Developing Rugged Motors for Heavy Duty in Railroad Service

Committee:—

E. Wanamaker, Chairman, Elec. Eng. C. R. I. & P. R. R.; J. E. Gardner, Elect. Eng. C. B. & Q. Ry.; E. W. Jansen, Elec. Eng. I. C. R. R.; E. Marshall, Elec. Eng. Gt. Northern Ry.

To the Members:

The appointment of a committee to draw up motor specifications was decided upon by the Executive Committee after a study of existing conditions and the ensuing revelation indicating the necessity of a suitable standard basis of rating for the benefit of the manufacturer, purchaser and user of electric motors, other than traction, in steam railway service, it being now quite fully understood that the conditions under which such motors are operated and maintained are more exacting and severe than those incurred in ordinary industrial practice.

It is not the intent of the Committee to burden the report with a complete resume of all of the factors that were found to determine this condition. However, a few of the most obvious are briefly related herewith:

> The inherent necessity for railroad operating organizations to be divided and sub-divided into major and sub-departments, for the operation of the railroad as a whole (as has been demonstrated by years of successful railway operation), necessitates a division of jurisdictional responsibilities. It is this fact (or facts), that primarily forces railroads to use more substantial and rugged motors for the various services for which they are employed, than those that are used in ordinary industrial service;
>
> The fundamental fact that motors are used to operate many devices, such as pumping stations, coaling stations, turntables, roundhouse equipment of all kinds, terminal equipment, and important or key machine tools, all of which are of primary importance as regards continuous operation, and must function with minimum failure if train schedules (the most important thing on a railroad) are to be efficiently and economically maintained;
>
> The distributing or scattering of the motors over a large territory instead of being concentrated at one point.

A careful study, analysis and digest of these fundamental principles will indicate to the analyst the many reasons loudly demanding such a motor specification as is embodied in this report.

Your committee began holding meetings early in the year—six different meetings of the committee having been held, including three open meetings, to which an invitation was extended to all motor control manufacturers, and the Electric Power Club, to have their representatives present, resulting in a very large attendance of those to whom the invitation was extended.

These meetings were all conducted with a spirit of co-operation, it being the concensus of opinion of those gathered at the meeting that it was possible to develop a specification that would be beneficial to all concerned—that is, to the manufacturer, the purchaser and the user.

The discussions at these meetings were very complete and every detail was thoroughly investigated, with the result that on June 26, at the last open meeting of the Specification Committee, the specifications herewith embodied were universally agreed upon.

MOTOR SPECIFICATIONS

Intent and Scope

It is the intent and lies within the scope of these specifications to guide the purchaser in the selection of and the manufacturer in the furnishing of electric motors for steam railway service. There are two primary factors which make is desirable to formulate such a specification.

First. The fact that motors in steam railway service are operated and maintained under conditions peculiar to that service.

Second. The fact that motors as offered to the railroads by the various motor manufacturers differ widely in quality and design for the same sized motor as identified by horse power and speed.

Uninterrupted service is of first importance. Because of wide distribution of motors, the commercially practicable impossibility of accurately predicting and maintaining the exact load requirements, and the lack of competent supervision in isolated localities, it is essential that motors supplied to the railroads shall be liberal in mechanical and electrical design.

With these points in view, motors furnished under these specifications shall fully meet the following requirements:

Specifications for continuous duty A. C. and D. C. open type motors, from 1 H.P., 1,800 R.P.M. to 75 H.P., 900 R.P.M. inclusive.

1. *Overload Capacity*

   (a) Temperature.—An observable temperature of 95° C. shall not be exceeded when the motor is subjected to a 25% overload for two hours immediately following continuous operation at full load with a room temperature of 40° C.

   (b) Commutation.—Direct current motors shall operate with full field from 0 to 150% load without any sparking.

2. *Bearings*

   (a) The bearings shall be of such size and capacity as to insure constant operation with freedom from heating, when the motor is subjected to conditions equaling or being comparable to an imposed overload of 250%.

   (b) When babbitted bearings are furnished, the shells shall be of ample thickness to permit rebabbitting without warping.

3. *Shafts*

   Shafts shall be so designed as to be free from excessive spring or vibration when operating under the overload conditions hereinbefore specified, when the driving pinion or pulley is applied in conformance with approved engineering practice.

4. *Bearings and Housings*

The bearings and housings shall be so constructed as to entirely prevent the escape of lubricant.

Specifications for intermittent duty A. C. and D. C. open type motors, from 1 H.P., 1,800 R.P.M. to 75 H.P., 900 R.P.M. inclusive.

When motors are furnished under this specification, having short time ratings, the total observable temperature rise shall not exceed 90 degrees C. with room temperature 40 degrees C.

When intermittently rated motors are required, complete data shall be supplied as regards the service for which the motor is intended.

When requested, manufacturers furnishing motors under these specifications, will supply data sheets, including power factor, efficiency and torque characteristics.

All electrical tests shall be conducted in conformance with the rules and requirements of the American Institute of Electrical Engineers.

Your committee after careful deliberation recommends that the specification be accepted by the Association, and that the members of the Association make use of same by ordering motors in accordance with the motor specifications of the Association of Railway Electrical Engineers.

Your committee desires to herewith extend their sincere thanks in behalf of the Association, to the motor and motor control manufacturers and the Electric Power Club, who by their hearty co-operation have made this specification possible.

Respectfully submitted,
COMMITTEE ON MOTOR SPECIFICATIONS.

Report of Committee on Insulated Wires and Cables

A. R. E. E. Representatives Co-operate as Joint Sponsor with American Engineering Standards Committee to Unify Specifications

Committee:—

J. R. Sloan, Representative, Chief Electrician, Pennsylvania System.

L. S. Billau, Assistant Electrical Engineer, Baltimore & Ohio Railroad.

J. L. Minick, Assistant Engineer, Pennsylvania Railroad.

TO THE MEMBERS:

Under date of January 11, 1921, the American Engineering Standards Committee extended an invitation to this Association to be represented at a conference to be held in the board room of the American Institute of Electrical Engineers, 29 West Thirty-ninth street, New York City, on February 2, 1921.

The object of this conference was to decide:

First.—Whether the unification of specifications for insulated wires and cables for other than telephone and telegraph use shall be undertaken, either under some general plan covering substantially all the more important uses, or under one or more projects more restricted in scope.

Second.—If so, what the scope of the work shall be.

Third.—How the work shall be organized.

The conference was called as a result of the action of the Committee on Electricity of the American Railway Engineering Association in submitting its "Railroad Specifications for Electric Wires and Cables," with the suggestion that "eventually there may be uniform joint specifications for insulated wires."

The American Engineering Standards Committee, therefore, invited the following bodies to send representatives to attend this conference:

American Electric Railway Association.
American Institute of Electrical Engineers.
American Railway Association (Signal Division).
American Railway Engineering Association.
American Society for Testing Materials.
Associated Manufacturers of Electrical Supplies.
Association of Edison Illuminating Companies.
Association of Iron and Steel Electrical Engineers.
Association of Railway Electrical Engineers.
Electric Power Club.
National Electric Light Association.
National Fire Protection Association.
Society of Automotive Engineers.
Underwriters' Laboratories.
United States Bureau of Standards.
United States Navy Department.
United States War Department.

Messrs. L. S. Billau, Assistant Electrical Engineer, B. & O. Railway, and J. R. Sloan, Chief Electrician, Pennsylvania System, Central Region, were appointed to represent this Association.

When the conference was called to order by A. A. Stevenson, chairman, American Standards Committee, there were present the following:

NAME	REPRESENTING
C. R. Harte	American Electric Railway Association
F. J. White	American Electric Railway Association
W. A. DelMar	American Institute of Electrical Engineers
F. A. Laws	American Institute of Electrical Engineers
1 C. B. Martin	American Railway Engineering Association
2 George Genhauer	American Railway Engineering Association
Sidney Withington	American Railway Engineering Association
W. H. Bassett	American Society for Testing Materials
F. M. Farmer	American Society for Testing Materials
F. B. Waring	American Society for Testing Materials
S. C. Potts	American Society for Testing Materials
R. W. Atkinson	American Society for Testing Materials
R. A. Haislip	Associated Bell Telephone Companies
R. R. Williams	Associated Bell Telephone Companies
LeRoy Clark	Associated Mfrs. of Electrical Supplies
B. M. Tyler	Associated Mfrs. of Electrical Supplies
R. W. Langley	Associated Mfrs. of Electrical Supplies
3 E. T. Tanzer	Association of Edison Illuminating Companies
L. S. Billau	Association of Railway Electrical Engineers
J. R. Sloan	Association of Railway Electrical Engineers
Frederick Nicholas	Electric Power Club
W. Creighton Peet	National Association of Electrical Contractors and Dealers

4 E. P. Slack........Underwriters Laboratories
H. L. Johnston.....U. S. Navy Department
Edgar Russell......Col. U. S. A., U. S. War Department
A. A. Stevenson....Chairman, American Engineering Standards Committee
P. G. Agnew......Secretary, American Engineering Standards Committee

The following bodies had designated representatives, but they were unable to attend the meeting:

E. B. Meyer.......National Electric Light Association
W. S. Haggott....Society Automotive Engineers
Azel Ames.........Society Automotive Engineers
H. B. Burtley.....Society Automotive Engineers

1. Also representing American Institute of Electric Engineers.
2. For R. S. Parsons.
3. For Thomas Sproul.
4. Also representing National Fire Protection Association.

In order that all might be familiar with the work of the American Engineering Standards Committee, Mr. Stevenson gave an outline of the inception of the committee, its objects, and method of organizing and working approximately as follows:

The committee originally consisted of representatives of the American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers and American Society for Testing Materials, the constitution later being broadened to permit the representation of other bodies on the committee.

The objects of the American Engineering Standards Committee are:

(a) To unify methods of arriving at Engineering Standards, to secure co-operation between various interested organizations in order to prevent duplication of work and promulgation of conflicting standards.
(b) To receive and pass upon recommendations for standards but not to initiate or develop the details of any particular standard.
(c) To act as an authoritative channel of co-operation in international engineering standardization.
(d) To promote in foreign countries the knowledge of recognized American standards.
(e) To collect and classify data on standards and standardization bodies in the United States and foreign countries and to act as a bureau of information regarding standardization.

The Organization and Procedure are as follows:

1. The committee proper, the "Main Committee," is primarily an organizing co-ordinating and steering committee, and does not define or develop details of any particular standard.
2. Sectional committees are committees—one for each standard or group of standards—whose function is to prepare the standard or standards, under direction of the most vitally interested organization or organizations, known as sponsor.
3. The sponsor is a co-operating organization (or group of organizations) approved by the Main Committee, to organize and direct a sectional committee, for the development of any standard or group of standards. It is not necessary that a body be represented on the Main Committee in order to act as a sponsor.
4. Any standard or group of standards adopted or in process prior to January 1, 1920, may be approved by the Main Committee, if, in the opinion of the committee, it has been developed by a properly constituted committee, or has, by actual practice, proven its right to become a standard.
5. When the development of a particular standard or group of standards is proposed, the Main Committee assigns the work to the appropriate organization (or organizations) as sponsor.
6. The sponsor then appoints a sectional committee, subject to the approval of the Main Committee. The purpose of the approval is merely to assure the comprehensive representation of all interests involved. Fundamentally, the degree of success of any standardization work depends on the comprehensiveness of the representation on the committee developing the standard; in other words, the more broadly comprehensive the representation on the committee the more broadly will the standard be accepted.
7. A Sectional Committee dealing with standards of a commercial character (specification, shop practices, etc.) must be made up of producers, consumers and general interests—no one of which shall form a majority.
8. After a standard or group of standards has been prepared and approved by a Sectional Committee, it is submitted to the sponsor for its approval, and then to the Main Committee with its full history. Upon approval by the Main Committee it becomes an "American Standard," a "Tentative Standard," or a "Recommended Practice," according to the circumstances and the nature of the standard.
9. The scrutiny of a standard by the Main Committee is to make sure that the proper procedure was pursued, that the vote of approval was approximately unanimous, and that the standard is consistent with other standards—the Main Committee not to pass upon the details.
10. After approval by the Main Committee, the standard is published by the sponsor under appropriate title and over the statement "Approved by the American Engineering Standards Committee."

Following the above, there was a general discussion with reference to the particular matter before the meeting.

It was the unanimous opinion of those present that the proposed standardization was most desirable.

The question as to what association should sponsor the work provoked considerable discussion, but it was finally decided to recommend to the American Engineering Standards Committee that all associations accepting the call to the conference be invited to become sponsor for the proposed standard specification.

Under date of March 25, 1921, the Association of Railway Electrical Engineers received from the Secretary of the American Engineering Standards Committee a formal invitation to act as joint sponsor in the unification of specifications for insulated wires and cables for other than telephone and telegraph use.

The work to be taken up as outlined at the above mentioned preliminary conference was to include:

1. Conductors, quality, stranding, sizes.
2. Rubber insulation.
3. Varnished cloth insulation.
4. Impregnated paper insulation.
5. Magnet wire (including enamel, cotton and silk insulation).

6. Fibrous coverings (including asbestos).
7. Sheaths.
8. Armor.
9. Standard make-ups.

A meeting of the representatives of the bodies accepting joint sponsorship was called for April 7 in New York.

Reply was made acknowledging receipt of invitation and advising that Messrs. Billau and Sloan would represent the A. R. E. E. at this meeting and that the question of accepting sponsorship would be acted on by executive committee at its next meeting.

Under date of April 11, after consideration by your executive committee, the Secretary of the American Engineering Standards Committee was advised that joint sponsorship was accepted by the A. R. E. E. and that J. R. Sloan would be the representative with L. S. Billau, alternate.

At the meeting of April 7 there were present 22 individuals representing 11 associations. Six associations had definitely accepted sponsorship on this date, eight associations were uncertain as either no reply or an indefinite one had been received and two had definitely declined sponsorship, but had requested representation on the sectional committees.

The question of the number of representatives on the Sectional Committee was discussed and it was unanimously agreed 'that each body which participates in this work which represents consumers, shall have one (1) representative each; producers shall have two (2) representatives each; both consumers and producers, shall have two (2) representatives each; independent interests shall appoint one (1) representative each."

Also since the conference did not include representatives of all bodies invited to be present, it was, after discussion, unanimously resolved, that in order to expedite the work, a committee of five should be appointed by the Chair to:

(a) Collate information as to existing standard, and as far as possible circulate it to members of the Sectional Committee in advance of its first meeting.

(b) Act as temporary committee on form and scope to make recommendations for the consideration of the Sectional Committee.

(c) Determine the date of the first meeting of the Sectional Committee.

The Chair thereupon appointed Messrs. W. A. DelMal (chairman), E. B. Meyer, C. B. Martin, F. J. White and C. L. Warwick.

This committee of five, through the Secretary of the A. E. S. Committee, called a meeting in New York of January 6, 1922, at which the following was announced:

SPONSORS:

Americal Electrical Railway Association.
American Institute of Electrical Engineers.
American Railway Engineering Association.
American Society for Testing Materials.
Associated Manufacturers for Electrical Supplies.
Association of Edison Illuminating Companies.
Association of Railway Electrical Engineers.
National Electric Light Association.
National Fire Protection Association.
Underwriters' Laboratories.

OTHER CO-OPERATING ORGANIZATIONS:

Associated Bell Telephone Companies.
Bureau of Standards.
Electric Power Club.
Society of Automotive Engineers.
United States Navy Department.
United States War Department.

Organization	Representative	Business Affiliation	Sectional Committee Group
A. E. R. A.	F. J. White	Okonite Company	P
A. E. R. A.	C. R. Harte	The Connecticut Co.	C
A. I. E. E.	W. A. DelMar	Habershaw Electric Cable Co., Inc.	P
A. I. E. E.	E. B. Meyer	Public Service Elec. Co.	C
A. R. E. A.	E. B. Katta	N. Y. Central R. R.	C
A. R. E. A.	C. B. Martin	N. Y. Central R. R.	Alternate
A. S. T. M.	W. H. Bassett	American Brass Co.	P
A. S. T. M.	F. M. Farmer	Electric Testing Laboratories	G.I.
A. M. E. S.	W. I. Middleton	Simplex Wire & Cable Company	P
A. M. E. S.	V. M. Tyler	Acme Wire Co.	P
A. E. I. C.	Thos. Sproule	Public Service Elec. Company	C
A. E. I. C.	J. B. Noe	New York Edison Co.	Alternate
A. R. E. E.	J. R. Sloan	Pennsylvania System	C
A. R. E. E.	L. S. Billau	B. & O. R. R.	Alternate
N. E. L. A.	D. W. Roper	Commonwealth Edison Co.	C
N. E. L. A.	Wallace Clark	Genl. Electric Co.	P
N. F. P. A.	A. H. Nuckolls	Underwriters Laboratories	G.I.
Underwriters Laboratories	Dana Pierce	Underwriters Laboratories	G.I.
A. B. T. C.	R. A. Haislip	American Tel. & Tel. Co.	C
Bureau of Standards	J. F. Meyer	Bureau of Standards	G.I.
E. P. C.	Dan Harvey	Westinghouse Elec. & Mfg. Co.	C
S. A. E.	W. S. Haggott	Packard Electric Co.	P
S. A. E.	*		C
Navy	A. R. Cheyney	Bureau of Engineers	C
War	E. Eveleth Winslow	Col. 2nd Corp. Aria	C

* Official representative not yet designated.

Groups	Organizations in Each Group	Rep. in Each Group
Producers	6	7
Consumers	11	11
General Interests	4	4
Total	21	22

Actual member of organizations, 16.

A tentative set of rules covering the organization and procedure of the Sectional Committee was presented and discussed. A few amendments were proposed, some of which were adopted, the rules going into effect practically as proposed.

The committee of five suggested the following technical committees:

Committee No. 1. Definitions and Editing Committee.
Committee No. 2. Conductors.
Committee No. 3. Stranding.
Committee No. 4. Rubber insulation.
Committee No. 5. Impregnated paper insulation.
Committee No. 6. Varnished cloth insulation.
Committee No. 7. Magnet wire.
Committee No. 8. Fibrous coverings and fillers.

Committee No. 9. Metallic coverings.

Committee No. 10. Standard make-up for rubber insulated wires and cables.

Committee No. 11. Export.

To the above the meeting added:

Committee No. 12. Weather proof, heat resisting and similar wires and cables.

Members of the A. R. E. E. have been designated to serve on these technical committees as follows:

Committee 2. J. L. Minick.
Committee 3. J. L. Minick.
Committee 5. J. R. Sloan.
Committee 10. J. S. Billau.
Committee 12. J. S. Billau.

No meetings of Committee No. 10 as yet have been held, as the work of this committee is dependent on the work of other committees. Respectfully submitted,

JOINT SPONSOR COMMITTEE.

Report of Committee on Data and Information

Tabulated Information Reveals Rapid Growth of Electrical Applications and Portends a Still Greater Development in the Future

Committee:—

E. A. Lundy, Chairman, *Railway Electrical Engineer;* Edward Ray, Railway Purchases and Stores; J. E. Gardner, Electrical Engineer, C. B. & Q. Ry.

TO THE MEMBERS:

The report of your committee this year, which is the first report that has been submitted since 1918, indicates that the application of electrical appliances to steam railway service is increasing very rapidly. A close study of the following table will show that this is particularly true for industrial trucks, motors and electric welding outfits.

In making comparisons of the electrical equipment reported, it must be borne in mind that for no individual year were the same railroads represented. For example, this year we have reports from 64 railways representing 66% of the mileage in the United States and Canada and in 1918 there were 66 railways reported, representing 59% of the total mileage. However, 20 of the roads listed in 1918 report did not furnish us with data this year and 16 roads reporting this year did not appear in the 1918 report. Our totals for this year would have appeared even more imposing had we been able to secure data from a number of the roads reporting in 1918 and which did not report this time. Included in those roads are the New York Central lines, Boston & Albany, Michigan Central, Nickel Plate, Chicago & Alton, Erie, and Philadelphia & Reading.

The absence of the reports of these roads makes it very hard indeed to make an accurate comparison with previous years. Nevertheless the data we have secured will serve as a guide in showing the extent to which the installation of electrical equipment has progressed on individual railroads, and will also enable one to make comparison with other roads represented.

Marked progress has been made with electrical welding and motor application. The report this year showing 742 welders as compared with 348 in 1918 and 192 in 1916. Several roads reporting a. c. machines and also butt and spot welders.

The section covering motors is more complete than has been the case in any previous report. Fifty-six roads are included, the aggregate mileage of these roads being about 55% of the total for the United States and Canada. As nearly 30,000 motors were reported for these roads, we may logically assume that the number of motors for all of the roads would possibly total 55,000.

The committee wants to thank all those that have found time during the past troublesome months to assist in furnishing this data and information and sincerely hopes that the report may be of some little assistance in bringing to the attention of railway officials that electricity is playing an ever increasing part in the efficient and economical operation of our transportation system.

Respectfully submitted,

COMMITTEE ON DATA AND INFORMATION.

TABLE I

ELECTRICAL EQUIPMENT IN U. S. AND CANADA

	Totals reported		
	1916	1918	1922
Number of roads reporting	63	66	64
Total mileage	177,742	177,778	193,191
Car Lighting Data—			
Number of passenger cars operated	37,803	46,118	42,346
Number of cars electric lighted, owned by R.R. Co.	18,671	16,949	16,685
Cars electric lighted, operated by Railroad Co.	11,044	......	17,366
Number gas lighted cars	27,213	16,485	13,441
Number oil lighted cars	8,970	9,464	9,538
Number combinations with electric	3,523	......	3,456
Number of head end generating sets for lighting cars	296	336	525
Cars equipped with storage battery, used in head end trains	427	742	1,060
Axle generator system, number of cars, 60 volts	281	359	258
Axle generator system, number of cars, 30 volts	5,596	8,643	9,395
Axle generator system, number of cars, 24 volts	477	571	163
Straight storage system, number of cars, 60 volts	2,871	2,661	2,101
Straight storage system, number of cars, 30 volts	148	......	62
Industrial Trucks—			
Baggage handling	218	295	341
Freight houses and transfers	148	191	387
Battery and commissary	13	20	3
Electric tractors	2	9	23
Shop trucks	60	169	261
Total	441	684	1,015
Locomotive Headlights—			
Number of locomotives	48,976	45,887	49,130
Equipped with incandescent headlights	3,313	10,235	46,236
Purchased or Generated Power in Shops—			
Shops where power is purchased	322	444	683
H. P. total connected load	143,537	153,907	202,626
Shops where power is generated	220	316	401
H. P. total connected load	172,047	216,055	249,528
Generators, all Classes of Service—			
Number of generators, A. C.	200,258	182,161	195,451
K. V. A. capacity	320	382	373
Number of generators, D. C.	63,803	79,664	79,335
K. W. capacity	595	709	772
Motors—			
Number, D. C.	8,904	......	11,570
H. P.	140,892	......	180,859
Number A. C., single phase	114	......	439
H. P.	319	......	1,881
Number A. C. two-phase	1,184	......	1,920
H. P.	21,199	......	32,020
Number A. C., three-phase	6,790	......	15,786
H. P.	134,750	......	304,120
Welding Outfits—			
Number of welding sets	192	348	742
A. C.	......	3	42
D. C.	192	345	700
Number of single operator sets	......	......	548
Number of multiple operator sets	......	......	176
Number of automatic arcs	......	......	4
Number of spot welders	......	......	8
Number of butt welders	......	......	13
Lifting Magnets—			
Total number	18	198	275

	welding outfits							Lifting magnets									
				Recommended A. N. P. rating													
	Automatic arcs	Butt welding machines	Spot welding machines	One operator	Two operators	Three operators	Four operators	Size	Number	Size	Number	Size	Number	Size	Number	Voltage recommended	Class of service
	..	1	..	150	300	450	600	......	..	......	..	......	..	......	..	...	..
	..	2	..	200	300	500	600	36 in.	1	40 in.	1	43 in.	2	......	..	220	S
	..	..	1	...	...	...	...	42 in.	3	43 in.	10	45 in.	10	48 / 55	3 / 1	220	S
	..	..	..	200	300	500	600	21 in.	1	16 in.	1	......	..	......	..	220	S
	..	..	..	...	...	...	...	42 in.	1	54 in.	1	......	..	......	..	220	G
	..	..	..	225	400	500	750	3,250 lb.	42	7 crane having generator and 6 magnets					..	220	S
	..	..	..	200	...	...	...	3,200 lb.	5	......	..	......	..	......	..	220	G
	..	..	..	200	400	600	800	3,000 lb.	1	......	..	......	..	......	..	220	S
	..	..	..	...	...	...	...	......	..	......	..	......	..	......	..	...	..
	..	..	..	...	...	...	...	......	..	5 ton	1	......	..	......	..	220	S
	..	..	..	...	...	...	...	......	..	......	..	......	..	......	..	...	..
	..	..	..	200	400	600	800	3,000 lb.	2	......	..	......	..	......	..	220	S
	..	..	..	150	300	450	600	10 ton	5	......	..	......	..	......	..	220	G
	..	..	..	175	350	500	675-1,000	......	..	......	..	38 in.	11	......	..	220	G
	..	1	..	300	...	...	...	18 in.	2	36 in.	2	52 in.	1	60 in.-62	2	220	H
	..	..	..	150	300	500	800	36 in.	2	43 in.	2	......	..	......	..	220	S
	..	..	..	...	...	...	...	......	..	......	..	2 ton	1	......	..	...	S
	..	..	..	200	300	400	500	43 in.	1	......	..	......	..	......	..	240	G
	..	..	..	...	...	...	...	43 in.	2	......	..	52 in.	3	65 in.	1	220	S
	..	..	..	200	...	...	...	......	..	......	..	......	..	......	..	...	..
	..	..	..	...	...	...	...	1½ ton	1	......	..	......	..	......	..	220	H
	..	..	..	150	...	...	500	8 ton	2	......	..	......	..	......	..	220	H
	..	..	..	...	...	...	...	......	..	......	..	......	..	......	..	...	..
	..	..	..	150	300	450	600	......	..	......	..	......	..	......	..	...	..
	..	1	1	200	400	600	800	36 in.	4	......	..	......	..	......	..	220	G
	..	.	1	...	...	...	...	2 ton	2	......	..	......	..	......	..	220	S
	..	..	..	200	...	...	...	8,000 lb.	2	......	..	......	..	......	..	250	H
	..	..	..	...	...	...	...	......	..	......	..	......	..	......	..	...	..
	1	..	..	60-600	...	...	...	......	..	......	..	......	..	......	..	...	..
	..	..	..	200	...	...	...	1 ton	1	2 ton	1	......	..	......	..	220	G
	..	..	..	...	...	...	...	......	..	......	..	......	..	......	..	...	..
	..	..	1	...	...	...	...	3,600 lb.	5	......	..	......	..	......	..	220	S
	..	..	..	175	...	...	...	......	..	......	..	......	..	......	..	...	..
	..	..	..	156	...	...	...	1 ton	1	......	..	......	..	......	..	220	G
	..	..	..	175	400	...	...	......	..	......	..	......	..	......	..	...	..
	..	..	..	...	...	...	...	......	..	......	..	......	..	......	..	...	..
	..	..	..	...	...	...	...	1,000 lb.	1	1,200 lb.	1	2.5 ton	1	......	..	...	G
	..	..	..	150	300	450	600	1,800 lb.	2	......	..	......	..	......	..	230	S
	..	..	..	...	...	...	...	3,000 lb.	1	......	..	......	..	......	..	220	G
	..	..	..	...	...	...	...	......	..	......	..	......	..	......	..	...	..
	..	..	..	...	...	...	...	6 ton	1	......	..	......	..	......	..	220	H
	..	..	..	...	...	...	...	10 ton	1	2½ ton	1	......	..	......	..	220	S
	..	..	..	200	...	...	600	2 ton	5	......	..	......	..	......	..	220	H
	..	..	..	125-200	250-900	375-600	500-800	14 in.	1	18 in.	2	36 in.	3	43 in. / 44 in.	3 / 1	220	G
	..	..	..	...	...	...	...	......	..	5 ton	1	......	..	......	..	220	S
	..	..	..	50-200	...	...	...	43 in.	1	52 in.	4	......	..	......	..	230	S
	..	..	..	200	400	600	800	......	..	......	..	......	..	......	..	...	..
	..	4	1	200	400	500	650	......	..	X	X	......	..	......	..	220	N
	..	..	..	...	...	...	...	2 ton	5	......	..	......	..	......	..	220	G
	..	..	..	200	...	...	...	45¼ in.	4	......	..	......	..	......	..	230	H
	..	..	..	100	...	...	...	......	..	6,000 lb.	1	......	..	......	..	220	H
	..	..	2	200	400	600	800	½ ton / 1 ton	6 / 31	2 ton / 2½ ton	4 / 2	6 ton / 10 ton	1 / 1	16 ton / 20 ton	2 / 1	220	H
	3	..	..	150	300	450	600	1 ton	2	......	..	......	..	......	..	220	S
	..	..	..	160	320	480	540	1,800 lb.	5	......	..	......	..	......	..	220	HH
	..	..	..	...	...	...	...	......	..	......	..	......	..	......	..	...	..
	..	..	..	...	...	...	...	......	..	......	..	4,000 lb.	2	......	..	125	H
	..	1	..	...	...	...	...	2 ton	2	......	..	......	..	......	..	220	S
	..	..	..	150	...	...	600	......	2	......	..	......	..	......	..	32	S
	..	1	1	200	400	500	600	2,500 lb.	1	3,000 lb. / 6,000 lb.	7 / 1	10,000 lb.	1	32,000 lb.	4	220	G
	..	..	..	200	400	600	750-800	44 in.	1	......	..	......	..	......	..	220-250	S
	..	..	..	150	300	400	600	36 in.	1	......	..	......	..	......	..	220	S
	..	2	..	...	...	...	...	......	..	32,000 lb.	8	......	..	......	..	220	SS
	..	..	..	200	400	600	800	40,000 lb	2	......	..	......	..	......	..	220	S
	..	..	..	140	280	...	...	5,000 lb.	1	......	..	......	..	......	..	230	S
1	4	13	8	...	...	...	...	Total in use—275									

**—Includes 150 24 v. axle light systems.
§—Includes 2 rotary converters, 600 Kw. D.C.

Report of Committee on Data and Information A. R. E. E. Table II

Miles of line	Railroad	Total passenger cars operated	Electric lighted cars owned by railway	Electric lighted cars operated by railway	Gas lighted cars	Oil lighted cars	Combination with electric	Head end generating sets	Cars equipped with storage battery used in head end trains	Axle generator system No. cars 60 volts	Axle generator system No. cars 30 volts	Straight storage system No. cars 60 volts	Straight storage system No. cars 30 volts
		Car lighting Data											
[illegible]	Atchison, Topeka & Santa Fe	1,999	752	365	526	356	....	....	....	....	1,117	....	....
[illegible]	Atlantic Coast Line	729	151	158	222	355	....	....	....	....	151	....	....
[illegible]	Baltimore & Ohio	1,464	495	495	573	396	....	127	....	1	351	....	14
217	Bessemer & Lake Erie	61	3	3	7	51	....	....	....	....	3	....	....
2,516	Boston & Maine‡	1,806	48	50	1,199	515	....	....	....	....	50	....	....
[illegible]	Buffalo, Rochester & Pittsburg	95	47	51	38	5	1	....	....	....	47	....	....
17,446	Canadian National**	2,142	625	625	602	641	74	....	....	....	549	....	2
[illegible]	Central Vermont	92	11	12	20	61	1	....	....	....	12	....	....
[illegible]	Charleston & Western Carolina	39	....	....	1	38	....	....	....	....	....	....	....
[illegible]	Chicago & Eastern Illinois	199	55	60	43	78	18	....	....	....	78	....	....
[illegible]	Chicago, Burlington & Quincy	1,345	840	1,040	41	444	487	52	271	31	1	2	....
[illegible]	Chicago Great Western	178	63	87	83	32	13	....	....	....	87	....	....
[illegible]	Chicago & North Western	1,885	355	355	1,032	651	312	26	43	16	72	....	....
[illegible]	Chicago, Milwaukee & St. Paul	1,687	979	979	14	672	979	71	208	9	6	7	....
[illegible]	Chicago, Rock Island & Pacific	1,147	530	530	406	211	5	29	....	....	470	....	5
[illegible]	C. C. C. & St. L.	595	309	309	201	66	16	....	....	35	273	1	....
[illegible]	Colorado & Southern	167	11	11	59	74	3	....	....	1	13	....	....
[illegible]	Delaware & Hudson	460	55	55	149	177	7	....	....	1	53	....	....
[illegible]	Delaware, Lackawanna & Western	1,043	339	384	335	159	2	....	....	....	334	....	....
[illegible]	Denver & Rio Grande Western	352	56	56	181	115	8	....	....	....	68	....	....
[illegible]	Duluth, So. Shore & Atlantic	64	22	22	40	28	29	3	....	....	....	....	....
459	Elgin, Joliet & Eastern	....	....	....	....	....	1	....	....	....	1	....	....
1,141	El Paso & Southwestern	76	37	37	33	6	4	....	....	1	37	....	....
765	Florida East Coast	127	71	71	5	49	11	....	....	....	59	....	....
9,816	Grand Trunk, Western Lines	110	20	150	60	30	10	....	....	....	20	....	....
	Grand Trunk of Canada	1,044	228	228	563	264	26	....	....	....	228	....	....
8,266	Great Northern	1,202	679	679	88	288	365	62	....	20	16	....	....
1,173	Gulf Coast Lines	87	27	27	29	31	3	....	....	....	27	....	....
437	Gulf, Mobile & Northern	32	2	2	....	....	....	....	....	....	1	....	1
350	Hocking Valley	71	16	16	40	15	....	....	....	....	16	....	....
425	Illinois Traction System	....	....	....	....	....	....	....	....	....	....	....	....
4,799	Illinois Central‡	261	525	525	448	288	....	....	....	....	....	....	....
1,160	International & Gr. Northern	122	8	8	85	25	4	....	....	....	12	....	....
	Los Angeles & Salt Lake	125	23	23	97	5	5	12	2	....	22	3	....
836	Kansas City Southern	86	....	....	63	16	....	....	....	....	....	....	....
297	Lehigh & New England	11	....	....	3	8	....	....	....	....	....	....	....
1,449	Lehigh Valley	493	429	429	....	64	....	....	....	....	429	....	....
395	Long Island	1,214	832	832	267	90	....	....	....	....	185	....	10
5,038	Louisville & Nashville	735	282	282	1	452	....	....	....	....	280	....	2
1,650	Minneapolis & St. Louis	34	27	39	5	99	1	....	....	....	27	....	....
1,215	Maine Central	295	20	20	125	145	5	....	....	....	[illegible]	....	....
4,348	Minn., St. P. & S. Ste. Marie	441	162	162	....	....	....	....	....	....	162	....	....
1,671	Missouri, Kansas & Texas	435	76	76	222	137	....	....	....	....	76	....	....
7,343	Missouri Pacific	779	216	338	270	281	12	....	....	....	216	....	....
1,161	Mobile & Ohio	134	3	31	75	19	....	....	....	....	....	....	....
1,987††	New York, New Haven & Hartford	2,424	1,137	1,137	1,220	67	2	....	....	....	963	....	....
568	New York, Ontario & Western	225	49	49	128	98	....	....	....	....	49	....	....
2,238	Norfolk & Western	538	259	259	....	....	....	....	....	....	259	....	....
6,656	Northern Pacific	1,023	600	714	28	283	458	66	464	16	....	8	....
	Oregon Short Line	293	140	157	131	8	138	6	2	1	15	2	2
	Oregon, Washington RR. & Navigation Co.†	249	17	17	25	48	114	9	9	....	3	....	....
10,531	Penna. System	6,998	3,650	3,650	1,131	755	....	....	....	58	1,517	2,075	....
2,239	Pere Marquette	386	139	139	25	222	9	....	....	....	139	....	....
225	Pittsburg & Lake Erie	130	57	57	75	....	5	....	....	1	56	....	....
119	Richmond, Fredericksburg & Potomac	85	29	29	45	10	....	....	....	....	29	....	....
1,776	St. Louis Southwestern	235	20	20	163	48	4	....	....	2	7	....	....
4,769	St. Louis-San Francisco RR.	698	292	360	210	196	....	....	....	....	292	....	....
3,563	Seaboard Air Line Ry.	400	138	138	105	131	8	....	....	1	137	....	....
7,118	Southern Pacific	1,527	149	213	1,221	89	19	15	....	11	126	....	12
1,953	Texas & Pacific	306	121	121	160	25	6	....	....	....	112	....	....
504	Toledo & Ohio Central	40	4	9	35	2	1	....	....	1	3	....	....
9,281	Union Pacific	834	379	591	227	53	292	47	67	52	49	....	....
2,473	Wabash	410	81	81	221	106	2	....	....	....	63	3	11
512	Wheeling & Lake Erie*	78	2	2	50	25	1	....	....	....	2	....	1
		42,346	16,685	17,366	13,441	9,538	3,456	525	1,066	258	9,395	2,101	62

A—Total mileage divided total belts.
B—Individual record each car.
BB—Rubber and canvas.

C—Condor.
D—Duck.
F—Flysco.

G—General and scrap.
H—Store and shop material and scrap.
HH—Transfer cranes and store department cranes.

SS—Store department.
X—No record.
Y—Balata.

YY—Comp.
aa—10,000 winter, 20,000 summer.
**—Includes Lorain & West Virginia Railway.

†—Includes 13-24 v. axle generator systems.
††—Covers Central New England Ry.; also headlight costs $2.52 per 1,000 miles.
‡—Includes 325 32 v. axle light systems.

*—Includes 136 24 v. axle light systems.
§—Includes 2 rotary converters, 400 Kw. D.C.

Total in use—375

Report of Committee on Illumination

Important Changes in the Preparation of Lamp Specifications Mark the Progress of the Lighting Art

Committee:—

L. S. Billau, Chairman, Assistant Electrical Engineer, Baltimore & Ohio Railroad; J. L. Minick, Assistant Engineer, Pennsylvania System; A. H. Gerald, Engineering Assistant Chief Electrician, Pullman Company.

To the Members:

The report of your committee this year will comprise primarily a review of the recent developments in the incandescent lamp and illumination field as applying to railroad conditions covering the following subjects:

First.—Incandescent lamps for train lighting service.

Second.—Incandescent lamp for locomotive cab and classification lighting service.

Third.—Developments in incandescent lamp field since 1920.

Fourth.—Digest of industrial lighting codes that have been issued by various States.

Fifth.—Recommended illumination intensities for various kinds of railroad buildings and other facilities.

Incandescent Lamps for Train Lighting Service

Since the adoption in 1920 of the constant wattage basis for rating of train lighting lamps there have been a number of developments in the lamps for this service, including the introduction of the 15 and 25 watt gas-fillled lamps and improvements in efficiencies of many of the other sizes. In tables 1 and 2 are listed the train lighting lamps now commercially available, these having been more or less arbitrarily divided into two groups comprising those lamps for which there is a large or increasing demand and those for which there is a limited or decreasing demand, these latter including some new types in which the demand has not as yet been established.

TABLE 1

Size in Watts	Type and Size of Bulb	Vacuum (B) or Gas Filled (C)	Lumens Rated Initial	Lumens Approx. Mean Through-out Life
Lamps for Which There Is a Large or Increasing Demand 30-34 Volt Range				
10	S—17	B	97	85
10	G—18½	B	92	81
15	S—17	B	154	133
15	G—18½	B	145	126
25	S—17	B	270	215
25	G—18½	B	245	210
25	PS—16 (White)	C	280	250
50	PS—20	C	740	675
75	PS—22	C	1,215	1,100
100	PS—25	C	1,700	1,530

TABLE 2

Size in Watts	Type and Size of Bulb	Vacuum (B) or Gas Filled (C)	Lumens Rated Initial	Lumens Approx. Mean Through-out Life
Lamps for Which There Is a Limited or Decreasing Demand 30-34 Volt Range				
15	PS—16 (White)	C	135	124
20	S—17	B	208	173
20	G—18½	B	196	170
50	S—19	B	560	390
50	G—30	B	560	437
50	PS—20 (White)	C	640	590
60-65 Volt Range				
15	S—17	B	144	125
15	G—18½	B	133	117
25	S—17	B	250	217
25	G—18½	B	235	205
50	S—19	B	530	400
50	G—30	B	535	428
75	PS—22	C	1,005	910
100	PS—25	C	1,460	1,310

It is obvious that both from the point of view of the railroads as well as the lamp manufacturers it is very desirable to reduce the number of kinds of lamps to a minimum consistent with meeting the various demands of train lighting service.

While it is recognized that there will always be a more or less limited demand for certain types of lamps to meet special requirements on various railroads, your committee believes that the sizes and types shown in Table 3 will meet the general requirements of train lighting service and that the railroads should confine their demands to these as far as possible.

TABLE 3

Size in Watts	Voltage Range	Bulb	Vacuum (B) or Gas Filled (C)
15	30—34	S—17	B
25	30—34	PS—16	C
50	30—34	PS—20	C
75	30—34	PS—22	C
100	30—34	PS—25	C

As the 15 and 25 watt gas-filled lamps are likely to be used to a large extent in fixtures where the bulb is exposed, they will normally be furnished in diffusing type of bulb (white enameled). As the 50-watt gas-filled lamp will replace the present 50-watt vacuum type lamp, and consequently be used largely with open-mouth types of reflectors, it is essential, in order to reduce objectionable glare, that the lamps in the service be bowl frosted (or bowl enameled). Your committee recommends, therefore, that the 50-watt gas-filled train lighting lamp be furnished normally with a bowl enameled bulb.

Incandescent Lamp for Locomotive Cab and Classification Lighting Service

There appears to be a growing demand for a tungsten lamp for steam locomotive cab and classification lighting service in a smaller bulb than the present standard S-17 bulb, as it will permit the use of somewhat smaller cab lighting fixtures. The lamp manufacturers have indicated that a 15-watt tungsten filament locomotive cab lamp in an S-14 bulb can be developed that should give as satisfactory results as at present lamp in the S-17 bulb. The S-14 bulb is approximately 11/16 in. shorter and ⅜ in. less in diameter than the S-17 bulb. The light center length will be approximately 2½ in. for the S-14 bulb, as compared to 3 in. for the S-17 bulb. Your committee is in favor of adopting the smaller bulb lamp, if service tests develop that its maintenance performance is as good or better than the present standard cab lamp. It is recommended that the lamp manufacturers complete development of this lamp and that during the coming year the railroads try it out on a large enough scale to determine its comparative merits under service conditions, with a view to securing sufficient data to permit reaching a decision at the next convention relative to adopting the S-14 bulb as standard for this service.

Developments in Incandescent Lamp Field Since 1920

The following are some of the more important developments of interest to railroad engineers that have taken place in the incandescent lamp field since the last report of the committee has been submitted:

Tipless Bulbs: During the coming year the incandescent lamp manufacturers expect to change over the

production of a considerable proportion of the various sizes and types of lamps from the tipped bulbs to the tipless bulbs. Gas filled train lighting lamps are now available in the tipless bulbs and vacuum type tipless train lighting lamps will be in production shortly after the first of the year. As to how soon tipless train lighting lamps will be regularly supplied and the length of the transition period is indeterminate, as it depends largely upon the time required to use up existing stocks of bulbs. During the transition period either type of bulb may be used in filling orders.

Mill Type Lamps: There has been considerable improvement in the construction of the so-called mill type of tungsten lamp and its use is rapidly extending where lamps are subject to vibration or other mechanical shock. Your committee has been unable this year to secure information relative to the performance of this type of lamp in extension cord service.

As now constructed the standard mill type lamp is a vacuum lamp, pear shaped tipless bulb, with coiled filament in ring-shaped mounting. The appearance of this filament mounting, particularly when the lamp is burning, is somewhat similar to certain of the gas-filled lamps, which has resulted in the impression that it is a gas-filled lamp.

It is not only a vacuum type of lamp, but it is actually somewhat less efficient than the standard tungsten lamp of the same sizes. Its use, therefore, should be confined to the service for which it is designed. The mill type lamp is now available in sizes and voltages shown in Table 4.

TABLE 4

Size Watts	Type Bulb	Voltage Range	Initial Lumens	
			Mill Type	Standard Type
25	P—19	110—120	210	240
50	P—19	110—120	455	510
50	P—19	220—250	410	455

Sign Lamps: While the subject of electric sign lighting is of minor consideration in the railway field, it is important that where electric advertising signs are used that they keep abreast with the latest practice. Developments in sign lighting lamps have been rapid and in line with other illumination practice much higher intensities are now being used to produce more brilliant and distinctive effects. The new types of sign lamps use the coiled filament ring type of construction which gives greater tip candle power and also use blue glass bulbs of the daylight lamp type, which gives the brilliant white color effect. The schedule of the new blue glass sign lamps is shown in Table 5.

TABLE 5

Volts	Watts	Bulb	Base	Filament Const.	Type
110—125	10	S—14 Blue	Med. Screw	Straight	Mazda B
110—125	15	S—14 Blue	Med. Screw	Coiled Ring	Mazda B
110—125	25	P—19 Blue	Med. Screw	Coiled Ring	Mazda B
110—125	50	P—19 Blue	Med. Screw	Coiled Ring	Mazda B
110—125	50	PS—20 Blue	Med. Screw	Coiled Ring	Mazda C
110—125	75	PS—22 Blue	Med. Screw	Coiled Ring	Mazda C

Lamps for Electric Hand Lanterns: Electric hand lanterns are beginning to be widely used in railway service, in which connection there has been developed a lamp specially designed for use with the type of hand lantern employing a 4-cell dry battery. This lamp is designated as a 5-volt, 0.15-ampere, G-4½ bulb, C-2 filament construction, miniature screw base, miniature tungsten filament lamp.

Voltage Standardization

An effort is being made to reduce the number of lamp voltages used, and to standardize on three voltages, namely, 110, 115 and 120. The advantages of such standardization is better service to the purchaser by reason of the larger stocks of the standard voltage lamps regularly carried by manufacturers and agents. The manufacturers, with the co-operation of the National Electric Light Association, are conducting an active campaign to get central stations and other classes of lamp purchasers who generate their own power to adjust their circuit voltages to one of the three standard voltages. Constant progress is being made in this direction as is indicated by the following table:

TABLE 6
Distribution of Lamp Demand by Voltage

Voltage	1918	1919	1920	1921
100—109	0.3%	0.6%	0.5%	0.4%
110	29.9	28.0	28.0	28.1
111	...	0.2	...	...
112	8.7	6.7	5.0	3.1
113	1.2	1.8	1.9	1.0
114	1.4	1.0	0.8	0.5
115	27.0	30.0	32.3	35.5
116	1.5	1.0	0.8	0.5
117	1.0	0.8	0.4	0.1
118	3.3	2.0	1.4	0.9
119	0.2	0.1	0.1	...
120	17.7	20.7	20.9	23.6
121—124	1.3	0.7	1.1	0.5
125	6.1	5.3	5.8	4.9
126—130	0.4	1.1	1.0	0.9
Total	100.0%	100.0%	100.0%	100.0%

Your committee recommends the use of standard voltage lamps wherever possible, but calls attention to the importance of having the circuit voltage the same as the lamp voltage.

Revision of Standard Incandescent Lamp Specifications

In the past the Standard Specifications for Incandescent Lamps have provided for the evaluation of lamp performance in terms of "useful life" defined as the life to 80 per cent of initial candlepower or previous failure at a specified initial efficiency.

Lamp and lighting developments of recent years have directed attention to the inadequacy of these provisions, and it recently has become evident that the old methods of life evaluation have been outgrown. In consequence during the past year a revision of these specifications has been undertaken with the result that a new form of Standard Specifications for Incandescent Lamps has now been adopted which is thought to be better adapted to the requirements and certain to lead to a more discriminating and satisfactory evaluation of life performance than that heretofore had.

The important changes from the old specifications are as follows:

1. Lamp quality is evaluated in terms of average total life and mean efficiency during life or for purposes of comparison and guarantee on the basis of the average total life corrected to a stipulated mean efficiency during life.

2. The foregoing guarantee is supplemented by a guarantee of minimum lumen maintenance throughout life, expressed in per cent of initial lumens, and guarantee of life at initial efficiency.

3. Since small numbers of test lamps may not fairly represent the average quality of lamps, tolerances are provided for possible variations in test results. The tolerance is greater for a small test quantity than for a large quantity, and these tolerances are adjusted to preserve the same probability of rejection regardless of the number tested.

4. Special provision is made for the rejection of lamps which show vital defects, the percentage for rejection

being smaller than formerly required for rejection for physical defects.

5. The methods of testing, evaluation of lamp performance, and determination of inherent lamp quality which are scientific subjects, are contained in the specifications proper, and are separated from the commercial questions of lamp efficiencies and lives, which are contained in the manufacturer's schedules.

6. The candlepower has been abandoned (except as a primary standard) and all light measurement is expressed in lumens.

Digest of Industrial Lighting Codes that Have Been Issued by Various States

During recent years a great deal of engineering study and research has been made in the general subject of industrial illumination, particularly the artificial lighting of factories, mills and other work places, with the result there has been very rapid and beneficial development in this field. To a considerable extent railroads have not kept abreast with the best illumination practice as applying to their shops, engine terminals, yards, etc. Your committee has felt, therefore, a brief digest of the industrial lighting codes and regulations that have been put into effect by various states and public regulatory bodies will be of value to railway electrical engineers not only as a matter of information, but to serve as a ready reference guide when laying out new or remodeling old installations. It should be specifically noted, however, that the illumination intensity values given in these codes are in most cases the minimum that can be used for the requirements consistent with safety and are much lower than recognized good lighting practice. It is probable that these limits will be raised from time to time as the general run of industrial lighting conditions are gradually improving.

The Illuminating Engineering Society has largely taken the lead in the development of this subject, in which connection it has prepared and issued a "Code of Lighting Factories, Mills and Other Work Places," which is becoming the basis for the enactments and regulations of the various governmental bodies interested in this subject. In December, 1921, this code was approved as an "American Standard" by the American Engineering Standards Committee.

The following contains a brief digest of the illumination requirements and intensities set forth in the codes of the various States governing industrial lighting. In this are also included the recommendations as contained in the Code of Lighting of the Illuminating Engineering Society for Mills, Factories and Other Work Places.

The rules or orders, as the case may be, are arranged in tabular form in Table 7 and the intensities specified by each of the codes are given in Table 8. The latter is of a general natuie only as not all of the codes give a detailed list of the more common industrial operations.

Rules and Orders of the Various Codes

Application of Code: Wisconsin: This code shall apply as a minimum requirement for the natural and artificial lighting of all factories, mills, offices and other work places.

Meaning of Terms: Wisconsin, California, Oregon

1. *Candle* (or candlepower) means the unit of luminous intensity maintained by the national laboratories of the United States, France and Great Britain.

2. *Lumens* means the units of luminous flux and is the quantity of light necessary to produce an average intensity of illumination of one foot candle over an area of one square foot.

3. *Footcandle* means the unit of illumination equal to one lumen per square foot. It is the lighting effect produced upon an object by a lamp of one candlepower at a distance of one foot.

4. *Photometer* means a standardized instrument suitable for making illumination measurements.

5. *Lamp* means that part of the lighting equipment from which the light originates.

6. *Local Lamps* (or lighting) means lighting units located close to the work, and intended to illuminate only a limited area about the work.

7. *Overhead Lamp* (or lighting) means lighting units installed above the ordinary head-level to secure a general illumination over a considerable area.

8. *Brightness* means the intensity of light per unit area emitted from, or reflected by, a body; and is usually expressed in candlepower per square inch.

9. *Glare* means any brightness within the field of vision of such a character as to cause discomfort, annoyance, interference with vision, or eye fatigue.

10. *Eyestrain* means a physiological condition of the eye resulting in discomfort, poor vision, or fatigue.

TABLE 7

Rules and Orders of the Various Codes

	Ohio	Wisconsin	Oregon	California	New York	Pennsylvnaia	New Jersey
Application of Code	....	Order 2,100	....	....	....	....	....
Meaning of Terms	....	Order 2,101	Rule 1	Order 1,500	....	....	....
General Requirements	Rule 1	Order 2,110	Rule 2	Order 1,501	Rule 50a	Secticn 1	Rule 1
Natural Light	....	Order 2,111	Rule 3	Order 1,502	....	....	....
Artificial Light	Rule 2	Order 2,112	Rule 4	Order 1,503	Rule 50c	Section 2	Rule 2
Shading of General Ltg. Units	Rule 3	Order 2,113	Rule 6	Order 1,505	Rule 50d	Section 3	Rule 3
Shading of Local Ltg. Units	....	Order 2,114	Rule 7	Order 1,506	..	....	....
Distribution of Light on Work	Rule 4	Order 2,115	Rule 8	Order 1,507	Rule 50e	Section 4	Rule 4
Emergency Lighting	....	Order 2,116	Rule 9	Order 1,508	Rule 50f	Section 5	Rule 5
Switching and Control Apparatus	....	Order 2,117	Rule 10	Order 1,509	....	Section 6	Rule 6
Maintenance	....	Order 2,118	Rule 11	....	....	....	....
Plans, Specifications, Inspection, Fees, Etc	....	....	....	....	....	....	Rule 7
Measurement of Intensity	....	....	Rule 5	Order 1.504	Rule 50b	....	....

11. *Shaded* means that the lamp is equipped with a reflector, shade, enclosing globe, or other accessory for reducing the brightness in certain directions; or otherwise changing or altering the distribution of light from the lamp.

Oregon and California Continue as Follows:

12. *Illumination* means the quantity of light received upon a surface; it is measured in foot candles or in lumens per square foot of area.

13. *Intensity of illumination* means the quantity of light received upon a surface, expressed in foot candles or in lumens per square foot of area.

14. *Footcandles at the work* means the intensity of illumination on the object upon which work is being performed.

15. *Footcandles at floor level* means the intensity of illumination on the floor of the space specified.

General Requirements: Ohio, Wisconsin, New York, New Jersey, Pennsylvania, Oregon, California

Working or traversed spaces in buildings or grounds of places of employment shall be supplied during the time of use with either natural or artificial light in accordance with the following orders:

Natural Light: Wisconsin, Oregon, California

Windows, skylights or other roof-lighting construction of buildings shall be arranged with the glass area so apportioned that at the darkest part of any working space when nominal exterior daylight conditions obtain (sky brightness of 1.50 candlepower per square inch) there will be available a minimum intensity equal to twice the permissible minimum intensity under artificial light, otherwise the artificial light of the proper intensity shall be provided.

Awnings, shades, diffusive or refractive window glass shall be used for the purpose of improving daylight conditions or for the avoidance of eyestrain wherever the location of the work is such that the worker must face large window areas through which excessively bright light may at times enter the building.

Artificial Light: Ohio, Wisconsin, New York, New Jersey, Pennsylvania, Oregon and California

When the natural light is less than twice the minimum permissible intensities of illumination set forth on the table, artificial light shall be supplied and maintained in accordance with the table.

Measurements: Oregon, California, New York

For the purpose of light measurements, a standardized photometer, certified by the proper department, shall be used and such measurements shall be made at the locations specified in the table.

Shading of Lamps for Over Head Lighting: Wisconsin, Oregon, California

Lamps suspended at elevations above eye level less than one-quarter their distance from any positions at which work is performed, or where places are traversed, must be shaded in such a manner that the intensity of the brightest one-quarter square inch of visible light source shall not exceed seventy-five candlepower per square inch.

Shading of Lamps for Local Lighting: Wisconsin, Oregon, California

Lamps for local lighting must be shaded in such a manner that the intensity of the brightest square inch presented to new from any position at which work is performed, shall not exceed three candlepower.

Distribution of Light on Work: Ohio, Wisconsin, Oregon, California, New York, Pennsylvania, New Jersey

The reflectors or other accessories, mounting heights and spacings employed with lamps shall be such as to secure a reasonably uniform distribution of illumination, avoiding objectionable shadows and sharp contrasts of brightness. If local lighting is used, there shall be employed, in addition, a moderate intensity of overhead lighting, with a minimum of not less than (California) ¼ foot candle.

Where a separate source of supply cannot be obtained for the emergency lighting, the feed for emergency lights must be taken from a point on the street side of the service equipment.

Where source of supply for the regular lighting system is an isolated plant within the premises, an auxiliary lighting system of sufficient capacity to supply all emergency lighting must be installed from some other source, or suitable storage battery; or separate generating unit may be considered the equivalent of such service.

Switching and Control Apparatus: Wisconsin, Oregon, California, Pennsylvania and New Jersey

Switches or other controlling apparatus shall be so installed that pilot or night lights may be controlled from a point at the main entrance of factory building. Pilot or night lights may be a part of the emergency lighting system.

All switching and control apparatus on emergency, pilot or night lines shall be plainly labeled for identification.

Maintenance: Wisconsin and Oregon

All lighting equipment and windows shall be periodically cleaned, inspected, kept in order and when defective, replaced, so that the intensities of illumination will never fall below those specified in the table (Oregon) ½ foot candle.

Emergency Lighting: Wisconsin, Oregon, California, New York, Pennsylvania, New Jersey

Emergency lamps shall be provided in all work space aisles, stairways, passageways, exits and fire escapes, to provide for reliable operation, when, through accident or other cause, the regular lighting is extinguished.

Oregon, California, Pennsylvania, Wisconsin and New Jersey Continue as Follows:

Emergency lighting systems, including all supply and branch lines, runways, raceways and supports, shall be entirely independent of the regular lighting system and shall be lighted concurrently with the regular lighting system and remain lighted throughout the period of the day during which artificial light is required or used.

New York, Oregon and California

Emergency lighting, where required, shall have a minimum intensity of ¼ foot candles.

Oregon, California and New Jersey

Emergency lighting systems shall, where the nature of the hazard is such as to require it, be supplied from a source independent of the regular lighting system wherever possible. This source of supply and controlling equipment shall be such as to insure the reliable operation of the emergency lighting system when, through accident or other cause, the regular system is not in use.

Plans, Specifications, Inspection, Fees, Etc.: New Jersey

Plans and specifications in complete detail of all emergency lighting systems shall be submitted in duplicate to the Bureau of Electrical Equipment, Department of Labor, for approval, before work is commenced. One copy of plans and specifications will be returned if found satisfactory, bearing preliminary approval, which will be sufficient authorization to proceed with the work. All electrical work shall be in conformity with the National Electric Code.

Upon completion of the installation an inspection of the finished work is required and notice of completion shall be filed with the supervising authority.

Under Chapter 17, Laws of 1918, a fee is charged for examining plans and specifications and inspection payable in advance, and at time of filing plans and specifications with application:

On cost of installation up to $500..............$1.00
On cost of installation from $501 to $1,000...... 2.00
On cost of installation over $1,000.............. 3.00

The following States have provisions as follows:

New York, Ohio and California: Processes otherwise safeguarded in which light is detrimental—0.00.

Oregon: General lighting for workrooms, minimum = 0.5, recommended = 1.0—2.0.

These States give tables of intensities for a wide range of processes: *New York, California, Oregon* and *Ohio.*

The *Wisconsin Code* gives productive intensities as follows:

Rough manufacturing, such as rough machining, rough assembly, rough bench work, foundry floor work 6.0

Rough manufacturing, involving closer discrimination of detail................................10.0

Fine manufacturing, such as fine lathe work, pattern and tool making; light colored textiles........15.0

Special cases of fine work, such as watch making, engraving, drafting, dark-colored textiles..........25.00

Office work, such as accounting, typewriting, etc..15.0

Recommended Illumination Intensities for Various Kinds of Railroad Buildings and Facilities

Numerous tests, as well as actual experience in factories, shops, etc., have proved conclusively that very much higher intensities of artificial illumination for industrial purposes over what were considered good practice up to two or three years ago, when properly protected against glare, are not only desirable, but represent a real economy in the way of increased production and decrease in spoilage. The illumination intensity values shown in Table 9 represent what is considered good illumination practice today and are offered as a general guide. Rather

TABLE 9

Name	Foot candles: Recommended	Foot candles: Limits for various conditions	Remarks
Shops—			
Roundhouses	8	6-10	Vertical illumination on sides of engine.
	5	3-6	Horizontal illumination.
Erecting shops.......	6	4-8	
Car shops...........	5	4-8	
Foundries	5	4-8	Also vertical illumination.
Machine shops.......	6	4-16	Refer to standard machine shop lighting.
Forge shops.........	5	4-8	
Wheel shops.........	5	4-8	
Power plants........	5	3-8	
Outdoor Structures—			
Scale houses.........	15	3-5	Local lighting on the scale beam and a low intensity of general lighting in room.
Yards	.025	.02-.05	This represents average general illumination intensity for storage yards, etc., and does not apply to special conditions existing in hump yards at switches, etc.
Turntables	1.0	...	Can be provided by single unit at each end of turntable.
Coaling stations.....	2.0	...	At loading points.
	1.0	...	Local points inside of structure.
Stations—			
Terminals	...	4-8	General lighting and local lighting.
Train sheds.........	2	...	Over passageways and platforms.
Way stations.........	...	2-4	General lighting and local lighting.
Loading platforms....	2	1-3	
Roads	0.25	...	
Storage	3	2-4	
Offices	10	6-12	
Shop offices.........	8	5-10	
Draughting rooms....	12	10-20	
Toilets washrooms....	4	3-6	
Docks	1.0	0.5-2	Unloading and loading points, etc.

TABLE 8

	Roads and Yards		Storage		Stairways Aisles		Rough (1) Mfg.		Rough (2) mfg.		Medium (3) mfg.		Fine (4) mfg.		Very fine (5) mfg.		Office work		Toilets and washrooms	
	Min.	Rec.	Min.	Rec.	Min.	Rec.	Min.	Rec.	Min.	Rec.	Min.	Rec.	Min.	Rec.	Min.	Rec.	Min.	Rec.	Min.	Rec.
New Jersey	.02	0.05 0.25	0.25	0.50 1.00	0.25	0.75 2.00	....	....	1.25	2.00 4.00	2.00	3.00 6.00	3.00	4.00 8.00	5.00	10.00 15.00	3.00	4.00 8.00	....	....
Pennsylvania	.02	0.05 0.25	0.25	0.50 1.00	0.25	0.75 2.00	....	....	1.25	2.00 4.00	2.00	3.00 6.00	3.00	4.00 8.00	5.00	10.00 15.00	3.00	4.00 8.00	....	....
New York..................	.02	....	0.25	....	0.25	....	0.50	....	1.00	...	2.00	....	3.00	....	5.00	....	....	....	0.5	....
California	0.2	0.05 0.25	0.25	0.50 1.00	0.25	1.00 2.00	0.50	1.00 3.00	1.00	2.00 4.00	2.00	3.00 6.00	3.00	4.00 8.00	5.00	7.00 15.00	....	....	0.5	....
Oregon	.02	0.05 0.25	0.25	0.50 1.00	0.25	0.75 2.00	....	....	2.00	3.00 6.00	....	....	3.00	4.00 8.00	5.00	10.00 15.00	3.00	4.00 8.00	1.00	1.50 3.00
Wisconsin	.02	0.05 0.25	0.25	0.50 1.00	0.25	0.75 2.00	....	....	1.25	2.00 4.00	2.00	3.00 6.00	3.00	4.00 8.00	5.00	10.00 15.00	3.00	4.00 8.00	0.5	1.5 3.0
Ohio	.02	0.25	0.25	0.50 2.00	0.25	0.50 2.00	0.50	1.00 3.00	1.00	2.00 6.00	2.00	3.00 9.00	3.00	4.00 12.00	5.00	8.00 10.00	....	....	0.25	0.50 2.00
I. E. S....................		0.05-0.25		1.0-2.0				2.0-5.0					5.0-10.0			10.0-20.0				0.50-2.0

wide limits are shown, due to the great variation in local conditions which have a bearing on the illumination requirements. In laying out new installations, it should be kept well in mind that there is a definite trend in the industrial lighting field towards still higher illumination intensities.

General lighting should be used wherever it may be possible or practicable to do so.

Strictly local lighting should never be used without a reasonable degree of general lighting. Two foot-candles is good practice in conjunction with local lighting.

In the train lighting field illumination practice has not kept pace with the developments in other fields. However, with the general introduction of the gas-filled lamp there are now indications of a decided tendency towards the use of higher intensities. There is but little data available of the actual illumination intensities being secured with the newer types of lighting units, but in general it can be stated that the typical coach installations using vacuum type of lamps give but an average intensity of 2 to 3.5 foot candles, while some of the newer installations with gas-filled lamps will give 4 to 7 foot candles.

For coach lighting service the use of the bowl enameled 50-watt gas filled lamp in deep bowl open-mouth type of reflectors with the units located on a two-seat spacing is recommended where it is desired to keep the power consumption reduced to a minimum and at the same time provide higher illumination intensities. Results of comparative tests of vacuum type of lamp and gas-filled type in coach lighting service are given in the 1920 report of this committee. Somewhat more pleasing effects with better diffusion of the lighting will be secured with 75-watt gas filled lamps in enclosing types of lighting units of suitable design. Where high intensity brilliant lighting effects are desired the 100-watt gas filled lamp in enclosing lighting units should be used.

Respectfully submitted,

COMMITTEE ON ILLUMINATION.

Report on Electric Shop Facilities and Equipment

Care and Attention to Apparatus is Manifested by Reduced Maintenance Cost and Reliable Machine Performance

Committee:—

E. H. Hagensick, Chairman, Electrical Engineer, U. P. R. R.; G. W. Bebout, Electrical Engineer, Chesapeake & Ohio Ry. Co.; George Dodds, Electrical Engineer, Delaware & Hudson Co.; J. C. McElree, Electrical Engineer, Central of Ga. Ry. Co.; E. S. M. Macnab, Car Lighting Engineer, Canadian Pacific Ry. Co.; Joseph A. Andreucetti, Assistant Electrical Engineer, C. & N. W. Ry. Co.

TO THE MEMBERS:

Your Committee was instructed to go into the question of keeping electrical equipment continuously in service giving recommendations in regard thereto, also in regard to the carrying of spare parts.

On account of the reduction of force last year and strike conditions this year, the Committee has been unable to give as much attention to the preparation of the report as desired, and if any points have been omitted that you feel are pertinent let us bring them out in the discussion so they will become a matter of record.

It was the thought of the Committee that it would be unnecessary to go further into the matter of general repair shop layout which was covered in the 1920 report as each installation of course would have to be handled separately, and numerous local conditions be taken into consideration so that further information in regard to a model shop would be of little value.

On steam railroads there is a large variety of electrical equipment used, in addition to that for train lighting, engine lighting, block signals and telegraph. Motors are used for operating shop machinery, power plant machinery, coaling stations, ice houses, pumps, cranes, draw bridges, turntables, transfer tables, welding units, battery charging outfits, elevators and numerous other purposes, also at a number of places electrical energy is manufactured by the railroads, and in addition, buildings and yards are lighted.

The aggregate connected load of motors on a modern railroad amounts to many thousand horse-power, and is being continually added to on account of the development of electrically operated labor saving devices and the replacement of belt driven machines with motor drive. This makes it more and more important for those in the electrical department to be in a position to recommend the proper equipment for new work in order that maintenance may be kept to the minimum. In this connection it is very desirable that all requisitions for electrical material be passed on by the electrical engineer before orders are placed. When this arrangement is followed a saving usually results as material already in stock can often be used to good advantage in place of that specified on the requisition. The same thing applies to the purchase of motors. Many times a motor conforming in size to others already in use can be ordered without detriment to the service thus resulting in an ultimate reduction in the number of repair parts to be carried for protection. It should be the aim in selecting motors for use on the railroad to standardize on as few different sizes and types as possible. In direct current motors this is especially desirable where they are being used on important machines or cranes for if proper consideration is given this matter at the time motors are purchased the minimum number of spare armatures, armature coils, bearings, etc., will be required to give first-class service. With alternating current induction motors it is of course important that they be of very nearly the proper size for a given duty, as there is a considerable loss of efficiency and a reduction in power factor when the motors are too large, but in railroad work it is very important to keep apparatus continually in service so that sometimes the matter of efficiency may be given secondary consideration.

The use of alternating current by the railroads is becoming more and more common by reason of the fact that a large percentage of power used is purchased, and of course practically all power generated for sale is

alternating current. At some terminals direct current is generated and is used altogether and in most large shops direct current is available for the operation of cranes and certain variable speed machine tools. Where both alternating current and direct current is available in the shop, care should be exercised in selecting the proper type of motor for a given machine. Usually the machine tool manufacturer is asked to recommend the type of motor, but sometimes it happens that the net cost to the railroad for a given motor driven machine will be less with a direct current motor than an alternating current motor, even though the direct current motor costs more. This is on account of the fact that a greater range of speed control is possible with a direct current motor, thereby, reducing the gearing required on the machine. This makes quite a difference in the purchase price of the machine and should reduce the maintenance of the machine.

There are very few things accomplished by direct current in the way of driving machinery that cannot be taken care of by alternating current apparatus; however, when power is purchased for a large shop it is now becoming quite common to have the power companies penalize the consumer for low power factor in view of which consideration should be given to the installation of a large synchronous motor for correction of power factor. In connection with this it is desirable to have a generator to furnish direct current for cranes and some of the variable speed tools. This power factor correction can also be obtained by using rotary convertors, synchronous motor generator sets, or by installing synchronous motor driven air compressors.

All of the foregoing items must be given consideration when new installations are being made as they all have a bearing on keeping equipment in service, and if properly handled the minimum number of spare parts will be required.

In the operation of terminals, there is no reason why the same size motor should not be used at all points for the same class of service, *i. e.,* turntables should all be equipped with the same size, type and speed of motor. The same should apply to the various motors required for operating coaling stations, provided, of course, that the same kind of energy can be purchased at each of the locations. Under such an arrangement we do not feel that it would be necessary to carry a spare motor of each of the sizes involved at each of the terminals, but feel that one motor of each size could take care of a division or a district, depending, of course, upon how many locations are to be protected. The spare motor should be carried by the store department at a centrally located point and all concerned should know where these spare motors are, so that they can be quickly requisitioned in time of need.

Periodical inspection should be given all electrical equipment to prevent little defects becoming serious and probably putting the equipment out of service. The inspection should be thorough and not just a matter of looking over the equipment without noting the small defects that may be developing. If inspections are made thoroughly they need be made only once a week on the average, and once a month is sufficient on the less important equipment, of course, the oiling and keeping of equipment must be taken care of, and the attention necessary depends on the service.

In addition to the foregoing inspection, which should be made by local electricians, we feel that it is very desirable

MOTOR NO.________ APPLIED TO MACHINE NO.________ DATE________

DESCRIPTION OF MOTOR________ BUILDER________

WINDING________ TYPE________ FRAME________ FIELD SERIAL NO.________

ARMATURE SERIAL NO.________ R. P. M.________ FRAME NO.________ PHASE________

CYCLES________ VOLTS________ AMPERES________ H. P.________

DESCRIPTION OF CONTROLLER________ BUILDER________

TYPE________ STYLE NO.________ SERIAL NO.________ (FOR ADDITIONAL DETAILS SEE OTHER SIDE)

DATE RECEIVED________ AT________ (RECEIVING POINT ON LINE) ROUTED VIA________

AUTHORITY FOR PURCHASE________ REQ'N NO.________ DATE________ WEIGHT, SHIPPING________ NET________

COST F.O.B.		FREIGHT MOTOR & CONTROLLER	FOUNDATION OR BRACKETS	COST OF INSTALLATION	TOTAL COST
MOTOR	CONTROLLER				
TRANSFERRED TO	MCH. NO.	MCH. NO.	MCH. NO.	MCH. NO.	MCH. NO.
PLACE					
SHOP					
DATE					

ABANDONED	CAUSE

FOUNDATION OR BRACKETS	MATERIAL	SIZE	DEPTH	EXCAVATION	CONCRETE	GRILLAGE	ANCHOR BOLTS NO.	SIZE
				CU. FT.	CU. FT.	BD. FT.		

ADDITIONS AND BETTERMENTS

DATE	KIND	COST	DATE	KIND	COST

SEE OTHER SIDE FOR REMARKS

All Information With Regard to Motor May Be Entered Upon a Card Similar to the Above With the View of Having the Record of Every Machine Immediately Available Regardless of the Number of Times It May Have Been Transferred

to have traveling inspectors to check equipment and make thorough investigation occasionally, being provided with necessary test instruments. The traveling electrician or inspector, in addition to making a thorough inspection at large terminals, should be required to make a periodical inspection at smaller terminals where motors and electrical equipments are used, but where regular electricians are not stationed.

In regard to spare parts for motors, we feel that a liberal supply of bearings should be available on each division to take care of motors on that division, as a bearing is usually the first thing to require renewal, in the event it has not been properly maintained.

To sum up the matter of keeping electrical apparatus in service, the whole thing resolves itself into the question of having faithful electricians in the various shops and terminals, who will take sufficient interest in their work to see that the equipment is properly lubricated and kept clean, and they must have sufficient ability to promptly repair minor defects when they are discovered.

On account of the fact that motors are frequently moved from one location to another, it is usually difficult in a few years to positively identify a given motor, in so far as date purchased, price, etc., is concerned. With the view of keeping a better record it is desirable to assign a number to each motor, preferably stenciling the number with a steel stencil into the frame of the motor near the manufacturer's name plate. All information in regard to this motor should then be entered on a suitable record card. Under such an arrangement if a motor is sent to a central shop for repairs, by reference to the railroad's own serial number full information is at once obtainable as to description, where the motor was last in service, etc., even though the manufacturer's name plate has been lost. The illustration shows such a record card.

There is one more point which does not have a direct bearing on this Committee's work, but which we feel should be called attention to, and that is the excessive use of incandescent lamps on many railroads, on account of their short life.

It has been found very desirable to check the voltage of power and lighting circuits occasionally, as there seems to be a growing tendency in the smaller towns to dispense with their generating apparatus, securing energy in wholesale quantities from transmission lines, and we have noted that when this is done, quite frequently excessive voltage prevails. This is not particularly detrimental for power apparatus, but is very expensive to the railroad company in their lighting, as the life of the lighting units is considerably shortened on account of excessive voltage. When a condition of this kind is discovered it is usually impossible to get the company furnishing energy to reduce the voltage and it becomes necessary to furnish lamps of proper voltage.

Your Committee recommends that the report be received as submitted, and the Committee be discharged.

Respectfully submitted,

Committee on Electric Shop Facilities and Equipment.

Report of Committee on Power Trucks and Tractors

Various Conditions Under Which It May Be Economically Beneficial to Use Material Handling Equipment

Committee:

Louis D. Moore, Chairman, Electrical Engineer, Missouri Pacific Railroad Company; C. G. Winslow, Assistant Electrical Engineer, Michigan Central Railroad; Ernest Lunn, Chief Electrician, The Pullman Company; J. W. Hughes, Electrical Engineer, Canadian Pacific Railway Co. (Lines East).

To the Members:

Description, Application and Cost of Power Trucks and Tractors

EXHIBIT "A"

General

In the report of your Committee at the last convention it made no attempt or any claim to more than outline the very broad field covered by the subject of Power Trucks and Tractors, endeavoring only to touch very lightly the "high spots" of the subject. An attempt was made to obtain some reliable cost data, with very indifferent success.

Your present Committee has attempted to follow up, in more detail than was possible formerly, the outline set forth in the report of your previous Committee, but wishes to impress upon all interested in the subject that the surface has hardly been scratched as yet.

Your Committee has attempted to make this report such that it may serve, in a very general way, as a guide to the selection of the proper type of equipment for any given class of service, provided a preliminary investigation shows power equipment to be desirable but wishes to urge that each contemplated installation be investigated separately and a decision reached on the merits of each individual case.

Gasoline Tractors

Description

Gasoline tractors are propelled by regular automobile engines, with the usual transmission, controls and steering wheel. They are made in three and four wheel and caterpillar tread types. One type Fig. 1 is an adaptation of the Ford truck to industrial tractive purposes.

Application

Gasoline Tractors find their best application where

(a) Electric current is not available for charging batteries;
(b) Frequent grades in excess of 5% are encountered;
(c) Roadways are very rough;
(d) High speeds are permissible or desirable, particularly over paved roadways.

While mechanically just as good as gasoline equipment, electric tractors, when applied as in (b) and (c) are apt to have too high battery discharge to last the day out.

Under such circumstances, with electrical equipment it is necessary to have spare sets of battery, at a large increase in investment, or to take considerable time re-charging the batteries in the tractors, which is often objectionable.

The service sometimes warrants the higher depreciation of the gasoline tractors as their first cost is considerably less than that of a corresponding electric tractor.

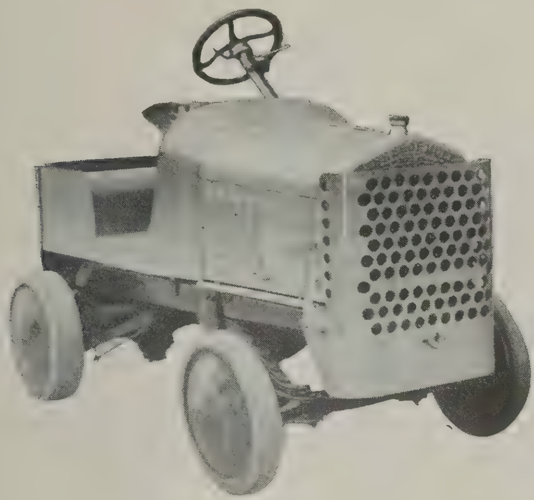


Fig. 1—The Shop Mule

The caterpillar tread tractor is very useful where soft ground is to be encountered, where additional tractive surface is required, or where extremely short turning radius is desirable, as these machines can revolve as on a pivot.

Electric Tractors

Description

Electric tractors derive their power from storage batteries, either lead or alkaline type, and are propelled by an electric motor suitably controlled from the driver's seat.

Fig. 2—Three Wheel Tractor

They are furnished in either three wheel or four wheel types, and are steered by either steering wheel or lever, operating in either vertical or horizontal plane and acting on either the front wheels only or on both front and rear wheels. One type of tractor Fig. 5, is designed to run in either direction, having two steering wheels acting on all wheels. The purpose of this arrangement is to avoid the necessity of turning in cramped quarters.

Electric tractors are furnished in various capacities. Practically all modern tractors are provided with a safety brake which is in operation whenever the driver is off of the seat.

Application

Electric Tractors find their most successful application in the handling of

(a) Freight, including cargo on steamship docks;
(b) Baggage, express and mail;
(c) Manufactured material around shops;
(d) Stores material.

In freight houses electric tractors are most suitable where they can be kept in operation the greater part of the day, usually involving hauls of five hundred feet or longer. Special consideration should be given each case, however, as there have been cases of short hauls handled economically with tractors.

The method of locating freight cars in the freight terminal determines to some extent the length of the haul, and consequently the type of equipment to be used, as at some terminals the cars are so "spotted" that it is necessary to transport the freight little more than across

Fig. 3—Four Wheel Tractor

the freight house, from the receiving door to the car or from the car to the delivery door. In others, hauls must be made the full length of the freight house.

A similar application is at steamship docks, where cargo is handled between vessel and freight cars. Often the trailers are loaded in the hold of the vessel, carried with their loads in slings to the dock and there made up into trains, or the reverse operation may be carried on.

Baggage, Express and Mail Handling:—Tractors are not recommended ordinarily for baggage handling, except in unusual cases. For express service, however, due to the fact that the shipments are delivered in large quantities and classified sometime before train time, tractors are particularly suitable. For the same reason they are very applicable to the handling of mail.

Handling of Material Around Shops:—Tractors are not generally applicable to shop work; however, where material is manufactured and used in sufficiently large quantities so that tractors can operate on a regular schedule, they can probably be used economically.

Handling Stores Material:—Tractors are not recommended ordinarily for handling stores material, on account of the lack of space in most stores buildings and the usual lack of sufficient business to keep them busy. In

some cases, where the storeroom is conveniently arranged for tractor operation and the quantity of material is large, they may be used to advantage.

Gasoline Trucks

Description

Gasoline trucks in industrial service are usually of the same type as the usual commercial street trucks, although certain special types have been developed such as that shown in Fig. 6.

Application

The same considerations governing the selection of tractors or trucks hold for gasoline equipment as for electric, and the selection of gasoline trucks may be determined by the same considerations as determine the selection of gasoline tractors, as enumerated under that heading.

Electric Load Carrying Trucks

Description

Electric trucks, like electric tractors, derive their power from storage batteries of either lead or alkaline type. The driver, however, usually stands on a small, low platform at one end of the truck, instead of being seated, and steers the apparatus by a lever working in a vertical plane, acting on either two or four wheels. The controller handle also usually operates vertically. Some trucks may be operated from either end, thus avoiding the necessity of turning them, and practically all trucks now have a safety brake which is in operation at all times when the driver is off of his platform, an automatic switch disconnecting the motor.

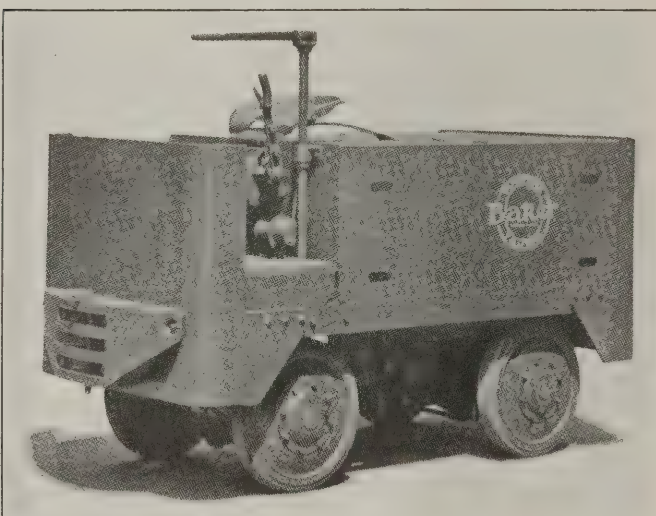


Fig. 4—Four Wheel Drive Tractor

Electric trucks are made in the following types:

(a) Baggage type, both straight frame and drop frame, Figs. 7 and 8;
(b) Low platform type, Fig. 9;
(c) Elevating platform type, Fig. 10;
(d) Tiering or Stacking type, Fig. 11;
(e) Crane type, Fig. 12.

Description

Baggage type: This type of truck is made in two styles, the "straight frame" or high platform and the "drop frame" or "underslung" model, having a low platform. These two types are shown in Figs. 7 and 8.

Application

The straight frame truck is used best where the station platform is at or near the track level, as it is then not necessary to lift the baggage any distance to the car floor. The drop frame truck, on the other hand, is most suitable for stations where the station platform is approximately on a level with the car floor. A variation of the use of the drop frame truck is to floor over the drop portion, piling trunks on the upper deck and hand baggage on the lower deck.

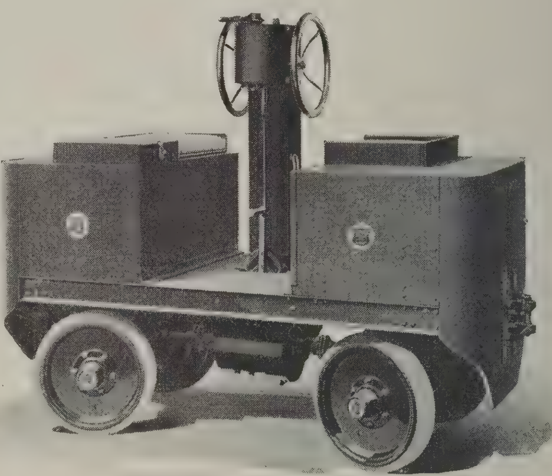


Fig. 5—Double End Tractor

Another application is at storerooms where house track is not provided with an elevated platform.

Description and Application

The low platform truck is a small truck with a platform a few inches above the floor level.

It is particularly suitable for use around storerooms where it is not necessary to lift the load more than a short distance above the floor. It is particularly applicable to handling small quantities which can be easily loaded by hand. They can also be used where an elevating platform truck might be desirable but is not justified by the amount of material handled.

Fig. 6—Special Type Gasoline Truck

Description

The elevating platform truck is similar in appearance to the low platform truck, but the platform can be elevated a few inches by means of an electric motor, thus enabling it to pick up material loaded on skids or low platform, move it from one place to another, and put it down, without the necessity of manual handling. It is one of the most useful of the various types of power equipment, as one man operating one of these trucks can move freight, supplies and

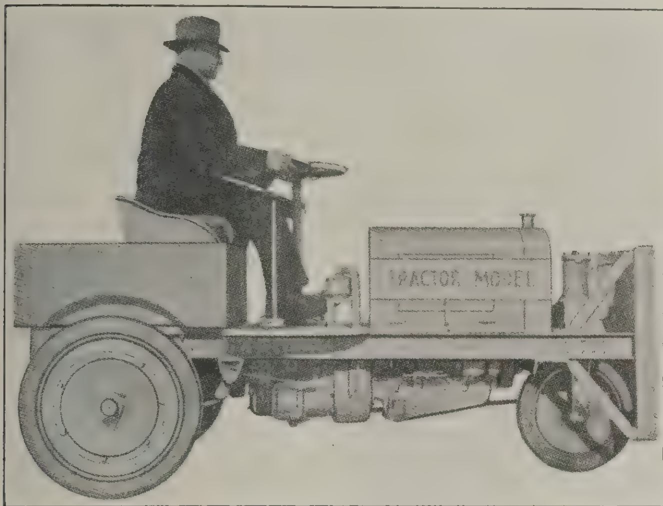


Fig. 6(a)—Another Special Type of Gasoline Truck

manufactured material from one place to another without the aid of a helper.

Application

In freight house work the elevating platform truck can be used for hauls which are too short for economical tractor operation, but where power equipment will speed up freight handling. As an example, shipments may be un-

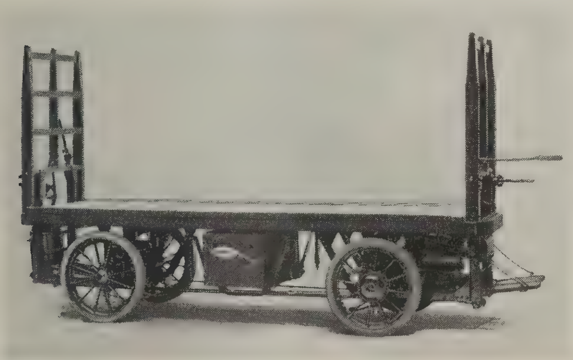


Fig. 7—Straight Frame Baggage Truck

loaded at the receiving door directly onto skids, the truck picking them up, taking them to the proper car nearby, leaving them to be unloaded by the stowers while it picks up another load, then returning for the empty skid and depositing it at the door for another load.

In storehouses, where a system of unit containers for shipping from one storeroom to another is used, the elevating type truck is particularly suitable, as the containers can be loaded into the car at shipping point and unloaded at receiving point without manual handling. Stores material can also be handled from car to bin in the same way as freight, as outlined above, or from storeroom to various shop departments.

In shops where one kind of material can be accumulated in bins or on platforms for a certain period and then distributed to other departments on schedule the elevating platform truck can also be used to advantage. As an ex-

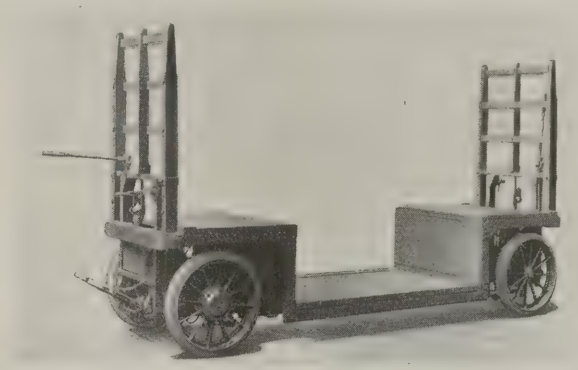


Fig. 8—Drop Frame Baggage Truck

ample, bolts and other parts that are manufactured in large quantities, can be put into bins directly from the machines, these bins resting on skids, and at stated intervals the elevating platform truck will pick them up and transport them to the storeroom or other department where they are used.

Description and Application

Stacking or tiering trucks are similar in appearance under normal conditions to the low platform truck. The platform, however, can be elevated to several feet (some as high as seventy-two inches) by means of an electric motor, so that its load may be raised to various levels. In storehouse work this type of equipment can be used for stacking boxes, barrels or sacks, such as boxes of soap, kegs of bolts or sacks of cement.

It may also be used at storehouses where house track has

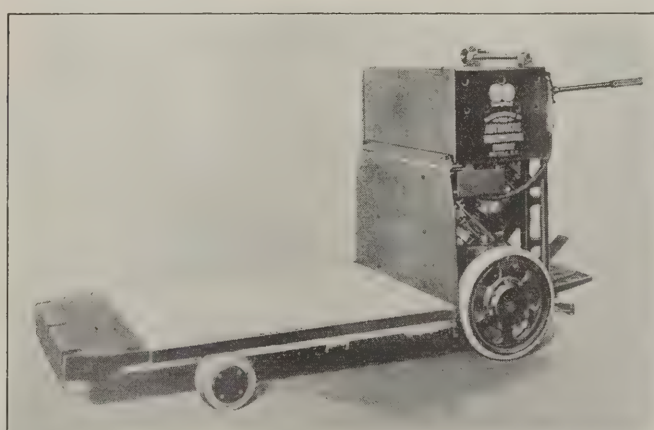


Fig. 9—Low Platform Truck

no elevated platform as its use will allow heavy castings and other shipments to be loaded at the storeroom floor and elevated to the level of the car floor and vice versa.

Description and Application

The crane type truck is usually a low platform truck with a crane installed on it, the crane being operated by an electric motor so that heavy castings and other heavy parts,

such as armatures, etc., can be handled with ease, either loading them onto the truck itself or onto a trailer, and unloading them at point of delivery. It is not recommended, however, that this truck be used for other than short hauls.

Some of these trucks are equipped with loading magnets, which greatly facilitate the handling of irregular shaped castings, etc., which can thus be handled without the aid of a helper.

Application Table

Following is given a table in which an attempt is made to show the type of equipment most suitable for various

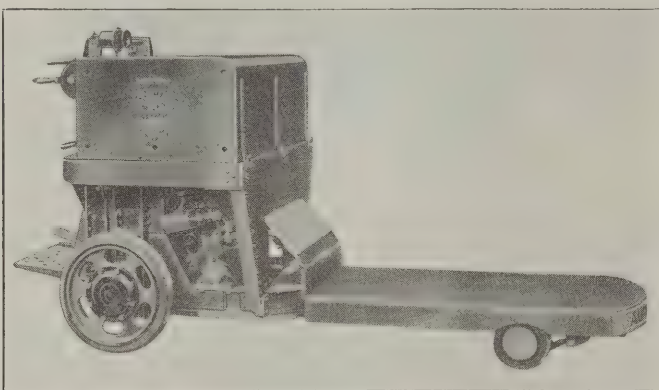


Fig. 10—Elevating Platform Truck

classes of service. There may be cases where other class of equipment than that shown will be more suitable, but it is believed this table will cover the majority of cases.

Table 1

Class of Service	Usual Kind of Equipment
Baggage and Mail	
Low Depot Platform	High Frame baggage trucks
High Depot Platform	Drop frame baggage trucks
Steamer Docks	Low platform freight trucks
Express	Four wheel tractors and trailers
Freight Houses	
Short Hauls (less than 500 ft.)	Elevating platform trucks
Long Hauls (500 ft. and longer)	Tractors and trailers
Steamship Freight Docks	
Covered	Low platform trucks
Open	Tractors and trailers
Storerooms and Warehouses	Elevating platform trucks Tiering Trucks Crane trucks
Shops—Manufacturing	Elevating platform trucks Crane trucks
Shops—Repair	Crane type trucks Elevating platform trucks
Shops—Electric Repair	Crane trucks
Yards—Passenger	Straight frame baggage truck Special battery truck

Advantages of Power Equipment

The advantages of power operated equipment may be divided into three general heads:—

(a) The avoidance of increased plant;

(b) The ability to handle the work with less labor, and

(c) Net money saved in actual handling.

Avoidance of Increased Plant

In many cases the use of power operated equipment, because it enables the material for freight shipments to be handled more quickly, obviates the necessity for increasing the storage space necessary to take care of such shipments as congestion is avoided by the speedier handling.

Ability to Handle Work With Less Labor

In times of labor shortage power equipment has in many cases proved the only means of keeping freight moving and handling stores material promptly. In the questionnaire which was sent out by the 1920 Committee to a large number of railroads and other users, quite a number stated that this was their sole reason for adopting power equipment.

Net Money Saved in Actual Handling

In the large majority of cases there is an actual money saving because of decrease of labor and increased speed of handling. In most cases a very appreciable decrease in labor rolls can be effected, varying from 25% to 50%, and the actual net saving in cost of handling material and freight seems to average 20% to 25% of the cost with hand trucks. The increased speed of handling material also effects indirect saving in that cars may be moved more promptly because of quicker loading and unloading and the necessity of enlarging the plant is avoided, especially in the case of freight houses.

As examples of some of the savings effected by the use of power equipment, the following may be interesting:

One railroad reports that eight trucks replaced forty-eight men at forty-three cents per hour, or about $200 per day, while the cost of operating the trucks (which are of the low platform type) is about $2.60 each per day or a total of about $20 per day. This latter figure, however, evidently does not include the cost of the truck operators. These trucks are in use on one of the Southern export docks.

An East Chicago manufacturer of cast pipe fittings uses trucks for handling pig iron, scrap iron and coke from storage to charging room elevator in the morning and for handling ladle of molten metal from cupola to pouring room in the afternoon. He states a truck saves two men,

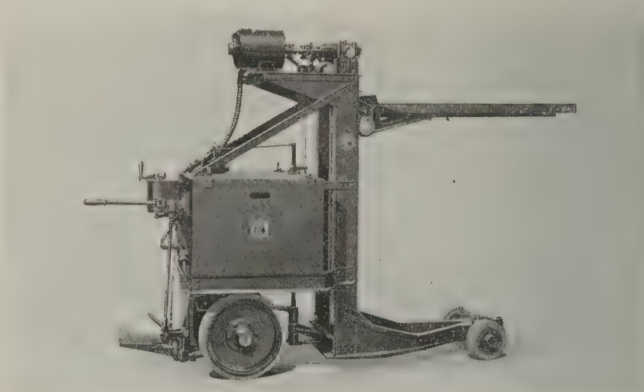


Fig. 11—Tiering Truck

formerly paid forty-five cents per hour, or about $2,700 per year.

Composition of Costs

In arriving at the cost of handling freight and materials by means of power trucks and tractors in general there seems to have been no fixed method adopted by the various users and many times all items of cost are not considered in arriving at the total cost of operation. The Committee has attempted, therefore, to outline what it believes should be the items entering into the cost of maintaining and operating power equipment, so that a uniform cost system

will be available. These items may be tabulated as follows, and follow the general lines of railroad accounting as laid down by the Interstate Commerce Commission:

Initial Investment

First cost of

(a) Power equipment, including battery and tires;
(b) Charging plant and garage;
(c) Trailers (for tractors);
(d) Skids (for elevating platform trucks);
(e) Hand trucks (where both kinds of equipment are used);
(f) Total initial investment (sum of items a to e, inclusive).

Operating Cost Per Annum

Fixed charges

(g) Interest on initial investment.......@ 6%
(h) Depreciation (Recommended for use in keeping cost records) power equipment less latteries and tires.........@ 6% to 10%
Charging plant and garage........@ 5%
Trailers ....@ 20%
Hand trucks ....@ 20%
(i) Taxes, at prevailing local rate;
(j) Insurance, of kinds appropriate to equipment;
(k) License (for street going trucks);
(l) Total fixed charges (sum of items g to k, inclusive).

Variable charges

(m) Electric current, number kw. hr. @....c per kw. hr.;

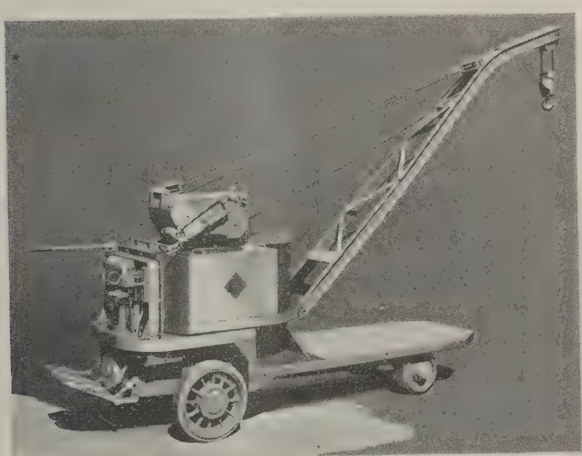


Fig. 12—Crane Type Truck

(n) Oil and grease (for both power and hand equipment);
(o) Labor—drivers and helpers (on power trucks and tractors and hand truckers);
(p) Labor charging batteries, oiling and greasing power equipment, trailers and hand trucks (proportion of garage attendant's wages);
(q) Battery renewals, for estimate use rate of annual depreciation for type of battery in use;
(r) Tire renewals, for estimate assume complete renewal annually;
(s) Bulb renewal for mercury rectifier sets;
(t) Total variable charges (sum of items m to s inclusive).

Maintenance Costs Per Annum

Repairs, including labor

(u) Power trucks and tractors (for estimating purposes 4% of value of equipment may be used);
(v) Trailers. For estimate purposes use 10% of value new;
(w) Hand trucks. For estimating purposes use 10% of value new;
(x) Charging equipment. For estimating purpose, use 4% of value new;
(y) Total maintenance costs (sum of items u to x).

Total Costs Per Annum

(z) Total of items (l), (t) and (y).

Discussion of Cost Items

One of most frequent errors in cost accounting is the omission of consideration of all related items. Thus, frequently the so-called cost is merely the cost of current, oil and operators, taking no account of fixed charges, and overlooking also the expense of repairing the equipment, including labor and material.

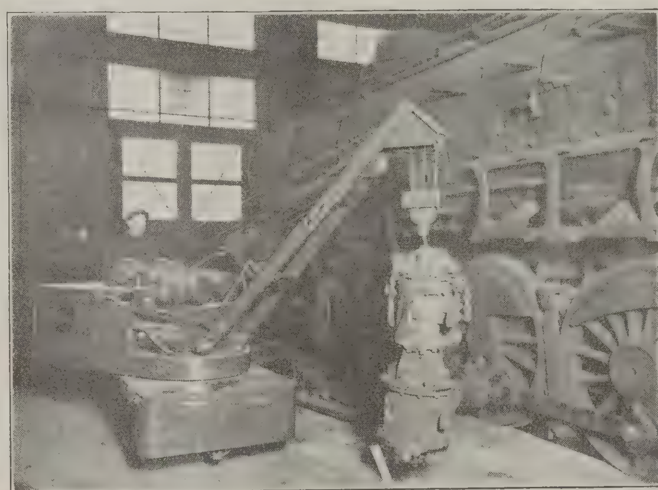


Fig. 13—Crane Type Truck for Heavy Duty

Initial investment should be considered on all equipment required to maintain and operate power trucks or tractors. For this reason your Committee has included such items as "charging plant and garage," "trailers," "skids" and "roadways." In most freight houses, and in many storehouses, hand trucks are used to supplement the power equipment, consequently, in order to arrive at the cost of operation it is necessary to consider their cost also.

The items of "fixed charges" are those generally recognized as applicable to any plant. The depreciation rates are those that would seem to agree with past experience.

The "variable charges" are what might be called "supplies." Batteries have been included under this heading, for the reason that they require renewing periodically, and tires have also been included for the same reason. The depreciations shown on these items for estimating purposes are those which past experience has shown to be usual.

Repairs on all items are shown, and the percentages shown for estimating purposes have been estimated. Needless to say, these percentages will vary with conditions of operation, but proper care in operation and

maintenance would seem to warrant these percentages.

For purposes of making up comparative costs of power trucking and hand trucking, the following items should be considered in arriving at the cost of hand trucking:

It is well, at this point, to discuss the method of arriving at the cost of labor for charging batteries as given in item "p" under heading "variable charges" and for repairs to trucks or tractors, as included in item "u" under "maintenance costs."

Where a special repair force is maintained which does no battery charging, or where the battery charging attendant makes no repairs, the case is simple. In the first instance, the labor would appear in the item "u" and in the second instance it would appear in item "p."

In a great many cases, however, the same man looks after charging the batteries and making repairs. In such cases, the Committee believes that a record should be kept of the actual time such a man spends in making repairs, and this amount should be charged under item "u." The balance of his time, that is, the difference between his total time and that actually spent in making repairs, should be charged under item "p."

Item "w" includes both labor and material required to maintain the charging equipment. It should cover repairs to bearings, commutators, starter and re-winding of armature or fields of motor generator sets; it should also include any repairs to the charging panel and to charging cords, plugs, and receptacles. Renewals of mercury tubes or bulbs, however, should be included under "operating costs" for the reason that, like incandescent lamps, they require periodic renewal.

The Committee has not referred to unit costs, as the units vary considerably, and if accurate data as to cost of operation is available, it is a very simple matter to divide such costs by the number of units handled to obtain the cost per unit handled.

The Committee submits for consideration at the annual meeting, its report as Exhibit "A" covering Description, Application and Costs of Power Trucks and Tractors.

Action Recommended

For discussion and continuation of Committee with instructions to continue investigation of the general subject in accordance with outline contained in 1920 Report.

Respectfully submitted,

COMMITTEE ON POWER TRUCKS AND TRACTORS.

Report of Committee on Electric Welding

Essential Requirements for the Construction of a Single Operator Direct Current Arc Welding Generator Set

Committee:—

H. R. Pennington, Chairman, Supvr. Welding & Elec. Equip., C. R. I. & P. R. R.; E. Hagensick, Elec., Union Pacific Ry.; E. S. M. Macnab, Eng. of Elec. Car Ltg., Can. Pac. R. R.; G. T. Goddard, Gen. Elec. Fore., I. C. R. R.

TO THE MEMBERS:

Your Committee regrets that conditions have been such during the past year, and especially since July 1, that they have been unable to formulate a report as broad in scope as had been originally intended. The original intention of the Committee being to formulate specifications for all of the various types of electric welding equipments such as are now in use. However, under the stress of existing conditions it was deemed desirable to confine the efforts of the Committee to drafting an equipment specification only for that equipment which is in the greatest general use. Hence, we are submitting herewith the following specification for single operator direct current arc welding generator sets.

SPECIFICATION FOR SINGLE OPERATOR, DIRECT CURRENT ARC WELDING GENERATOR SET

Intent and Scope

It is the intent and lies within the scope of these specifications to guide the purchaser in the economic purchase of commercially proven arc welding equipments.

(A) Generator

The generator shall be of the direct current, inherently regulating type, designed and equipped with the necessary auxiliaries to facilitate the satisfactory formation, maintenance and manipulation of the welding arc.

(B) Rating

(1) The continuous current rating of the generator set shall be stated when supplying energy continuously to a resistance load equivalent to a 22-volt arc, without any part of the unit exceeding a temperature rise of 50° C., with a maximum ambient of 40° C.

(2) The intermittent current rating of the generator set shall be stated when supplying energy for one hour to a resistance load equivalent to a 22-volt arc, without any part of the unit exceeding a temperature rise of 50° C., with a maximum ambient of 40° C.

NOTE (a) The operation of arc welding applies an intermittent load on the source of energy. The heating effect of such load on the generator will be determined by the welding duty cycle. To evaluate the above intermittent rating in terms of a welding load, attention is called to the fact that the continuous rating is approximately equivalent to operating the generator at a voltage of 22 when supplying the specified normal current to a welding arc for periods of 30 minutes after no load intervals of 20 minutes. This assumes the time required for changing electrodes, etc., of 5 seconds or less, as a negligible factor in the cooling of the unit.

NOTE (b) As the welding duty cycle will alter with the character of the application, it is suggested that an alternative rating be secured from the manufacturer when the estimated welding duty cycle differs radically from the above "equivalent" duty cycle.

NOTE (c) An intermittent current rating of from 150 to 200 amperes will meet the average requirements in many repair and production welding activities. Where it is feasible to maintain a high load factor on heavy parts in a well organized welding shop, an intermittent current rating of approximately 300 amperes is desirable.

(C) Operating Characteristics

(1) The operating characteristics of the generator and auxiliary equipment shall facilitate the formation,

maintenance and manipulation of a satisfactory welding arc over a current range extending from at least one-half of the intermittent current rating, preferably adjustable in steps no greater than 7½ per cent of the intermittent current rating.

(2) The sustained short circuit current shall not exceed 50 per cent nor shall not be less than 25 per cent of the intermittent rated welding current.

(3) The rate of current increase shall be such as to permit a stable arc to be drawn after electrode has been in contact for no more than ½ second.

NOTE (a) When welding with an average arc, the welding circuit shall have sufficient stability to prevent arc rupture due to momentary fluctuations of arc voltage as the result of sudden variation in arc length, caused by convection currents, gas blasts, or irregular metal deposition or electrode manipulation.

NOTE (b) To prevent excessive arc stability and the resultant hazard of excessive oxidation and insufficient penetration, the character of the welding circuit shall permit the maintenance of ½ in. arc at the intermittent current rating and fusion for no more than three seconds.

(4) The sustained open circuit voltage shall preferably not exceed 75 volts.

(5) The generator shall not lose its excitation nor shall its polarity reverse while maintaining welding arcs throughout the current operating range of the unit.

(6) It shall be possible to operate two or more units of the same type and manufacture in parallel to supply either a high current metallic electrode arc or carbon electrode arc.

(D) Commutation

The generators shall operate throughout the current range without sparking between the brushes and commutator.

(E) Control

(a) All necessary control devices shall be of such design and so installed as to insure safety of the operator.

(b) A suitable polarity reversing switch shall be provided, preferably located adjacent to the other control devices.

(F) General

(1) A substantial cover or enclosure shall be provided to protect commutators and brush rigging from injury.

(2) When direct current motors are used for driving the welding generators, it is preferable that the motor brushes and generator brushes be of different size, to prevent confusing same in their application.

(3) Motor starting switches shall be of an approved safety type—overload device being optional.

(4) As a rule it is preferable that the welding equipment be provided with one voltmeter and one ammeter with suitable range. This is especially true when new operators are employed, or men are being instructed in the welding arc process.

(5) The electrical and mechanical construction shall be such that there will be freedom from excessive vibration or spring of the shaft, or failure of any of the parts in ordinary commercial service.

(6) The bearings shall be ample and free from oil throwing.

(7) If the equipments are to be used as portable sets, strong trucks with anti-friction bearings, and preferable of a width that will permit their being moved through standard door openings are advisable, and it is preferable that the wheels be of sufficient diameter and width of tread to permit of easy moving It is generally preferable that the portable equipments be provided with suitable weather-proof housing or coverings.

Your committee wishes to herewith express their thanks to all those who assisted in preparing this specification.

Respectfully submitted,
COMMITTEE ON ELECTRIC WELDING.

Report of Committee on Heavy Electric Traction

A Tabulation of Important Data Relative to the Electrified Systems of North and South America

Committee:—

J. R. Sloan, Chairman, Chief Electrician, Pennsylvania System; J. H. Davis, Electrical Engineer, Baltimore & Ohio Railroad.

TO THE MEMBERS:

A number of organizations, such as,

- The International Railway Congress,
- The American Railway Engineering Association,
- The American Institute of Electrical Engineers,
- The National Electric Light Association,
- The American Railway Association, Mech. Section, and
- The American Electric Railway Association,

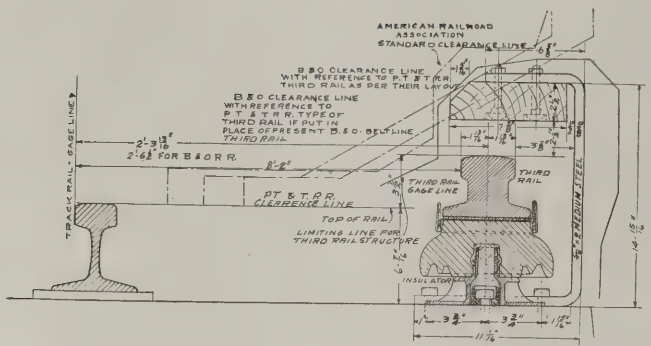
as well as our own Association, are interested in Heavy Electric Traction, and more or less frequently request certain data and information from the Railroads and Manufacturing Companies.

The requests for data and information have many times been burdensome to the recipients of these requests, especially so when practically the same information is desired, but in a different form. Realizing this, The American Electric Railway Association, Heavy Electric Traction Committee, in their 1920 report, called attention to the matter and issued an invitation to other interested organizations to have representatives meet with their Committee, with a view of co-operating and so reduce this burden.

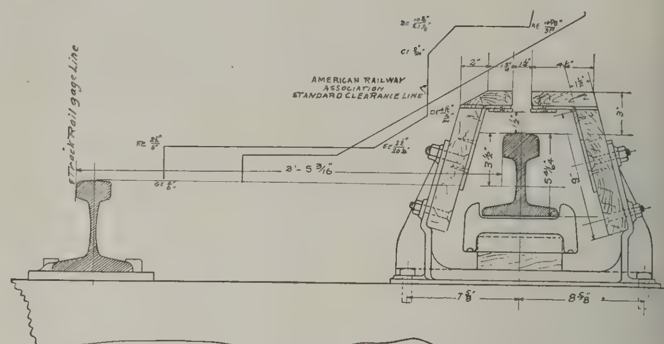
This invitation was accepted by your Association, and the Chairman of your Committee regularly attended the meetings of the Heavy Electric Traction Committee of the A. E. R. A., and it is with regret that it is reported that representatives of no other organization attended.

In the 1921 report of this Committee, "It is recommended that an effort be made to co-ordinate the activities of various organizations with the view of eliminating so far as possible over-lapping and duplication and of making more valuable to the profession the work of technical committees, etc."

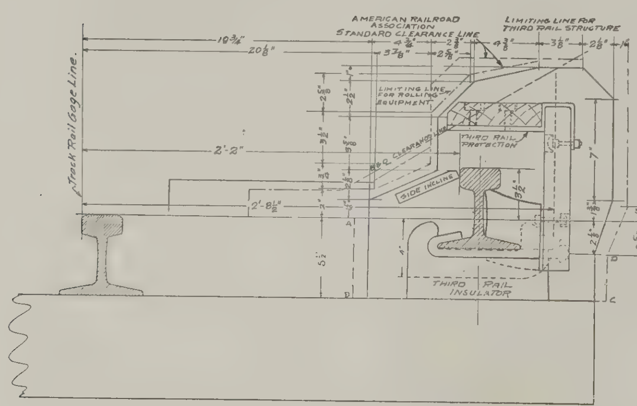
(*Continued on page 339*)



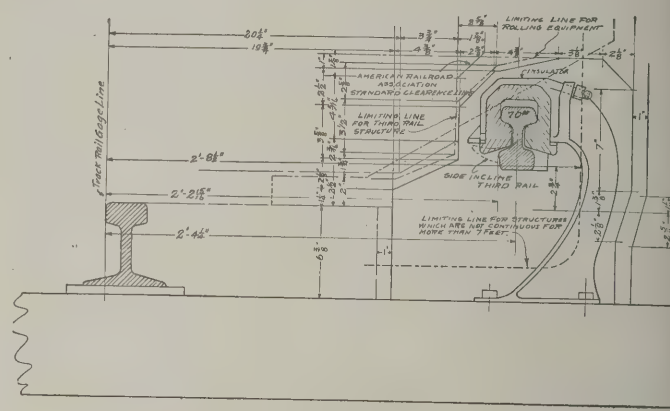
Top Contact Third Rail—Pennsylvania



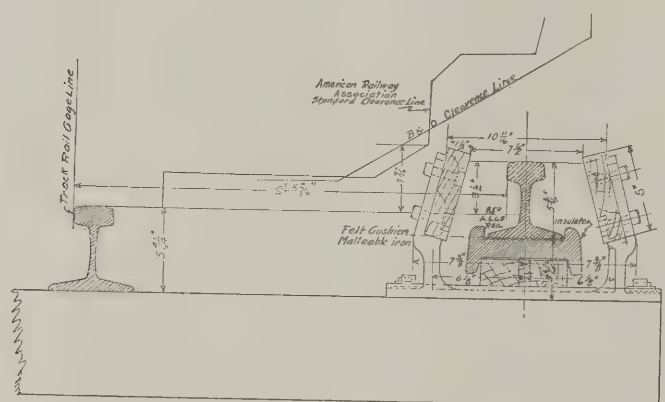
Protected Rail Used at Passenger Stations—Baltimore & Ohio



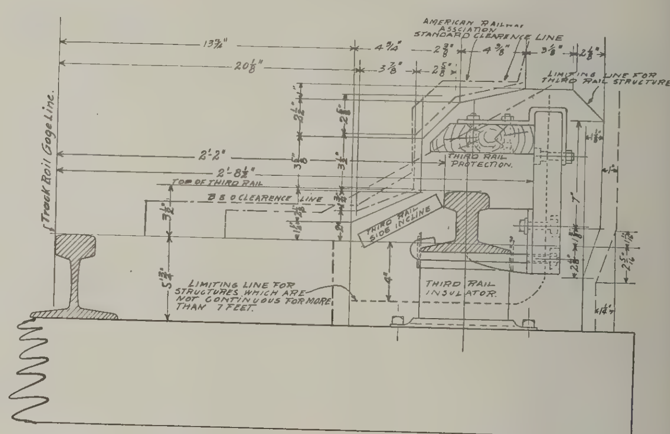
Top Contact Third Rail—West Jersey & Seashore



Under Contact Third Rail—New York Central



Top Contact Third Rail—Baltimore & Ohio



Top Contact Third Rail—Long Island

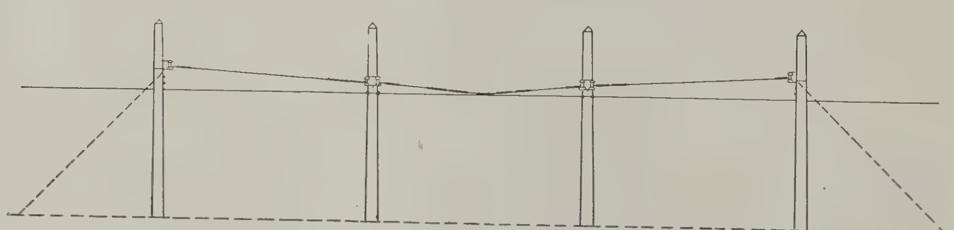


FIG. A- Line Anchor Scheme

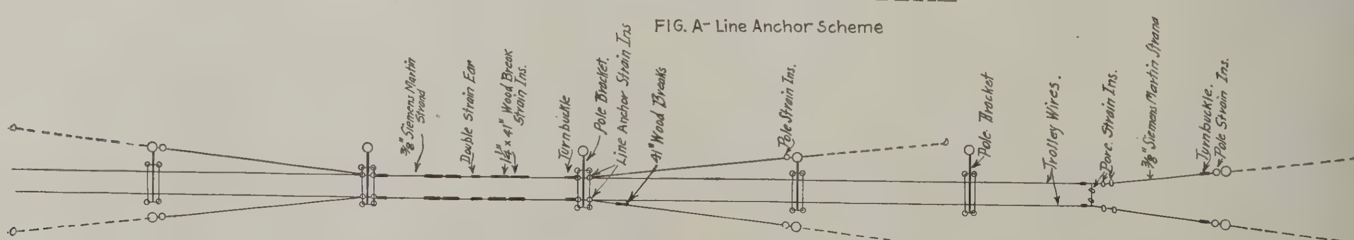
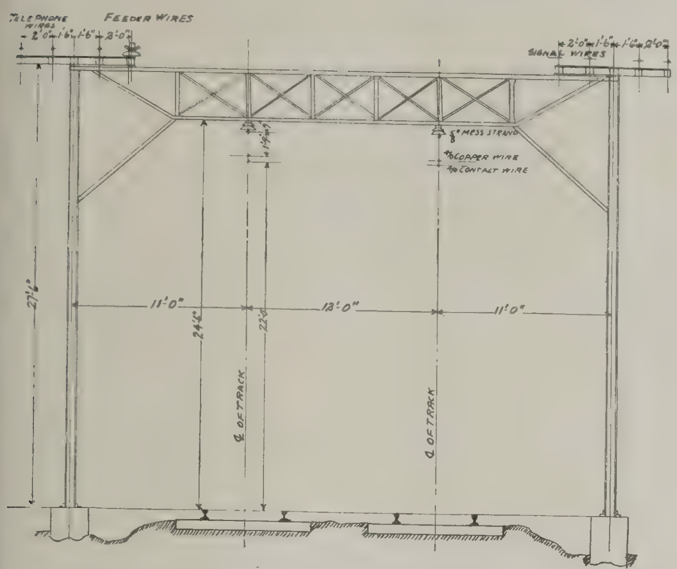
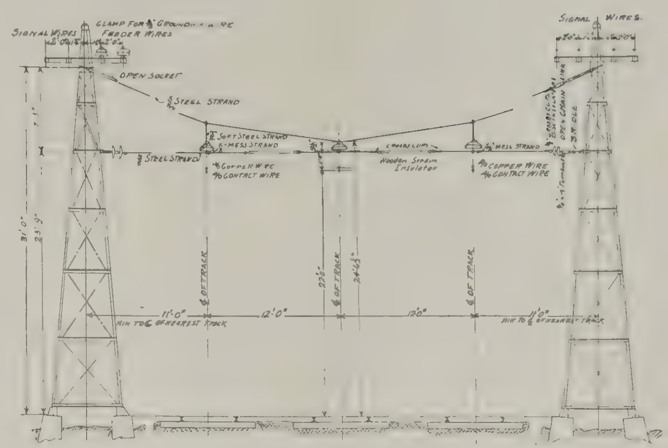


FIG.B- Double Ending Scheme

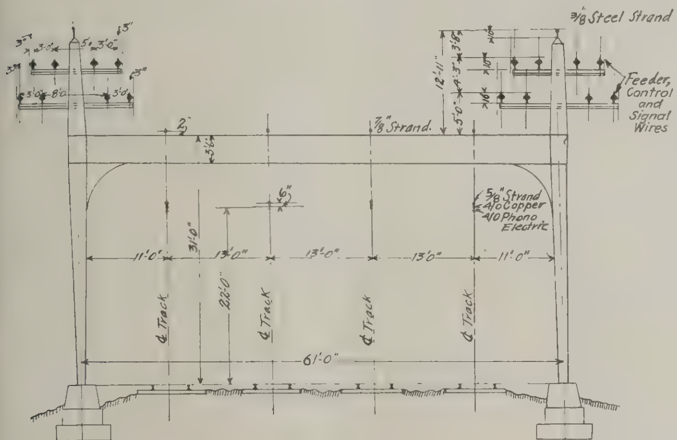
Line Anchor and Double Ending Schemes



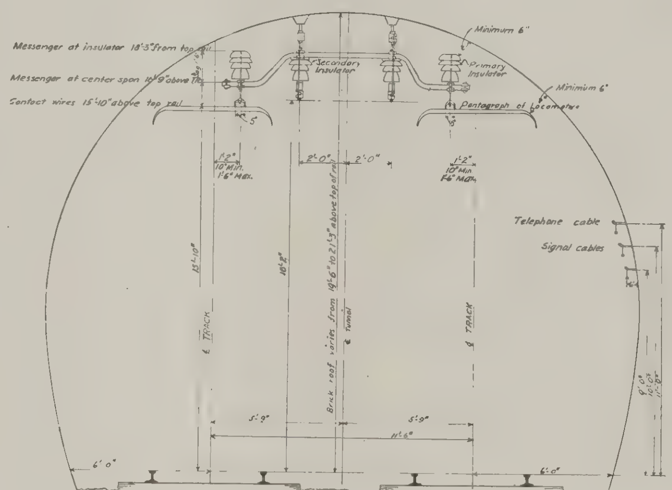
Bridge for Supporting Catenary Feeder, Telephone and Signal Wires on Two Track Line



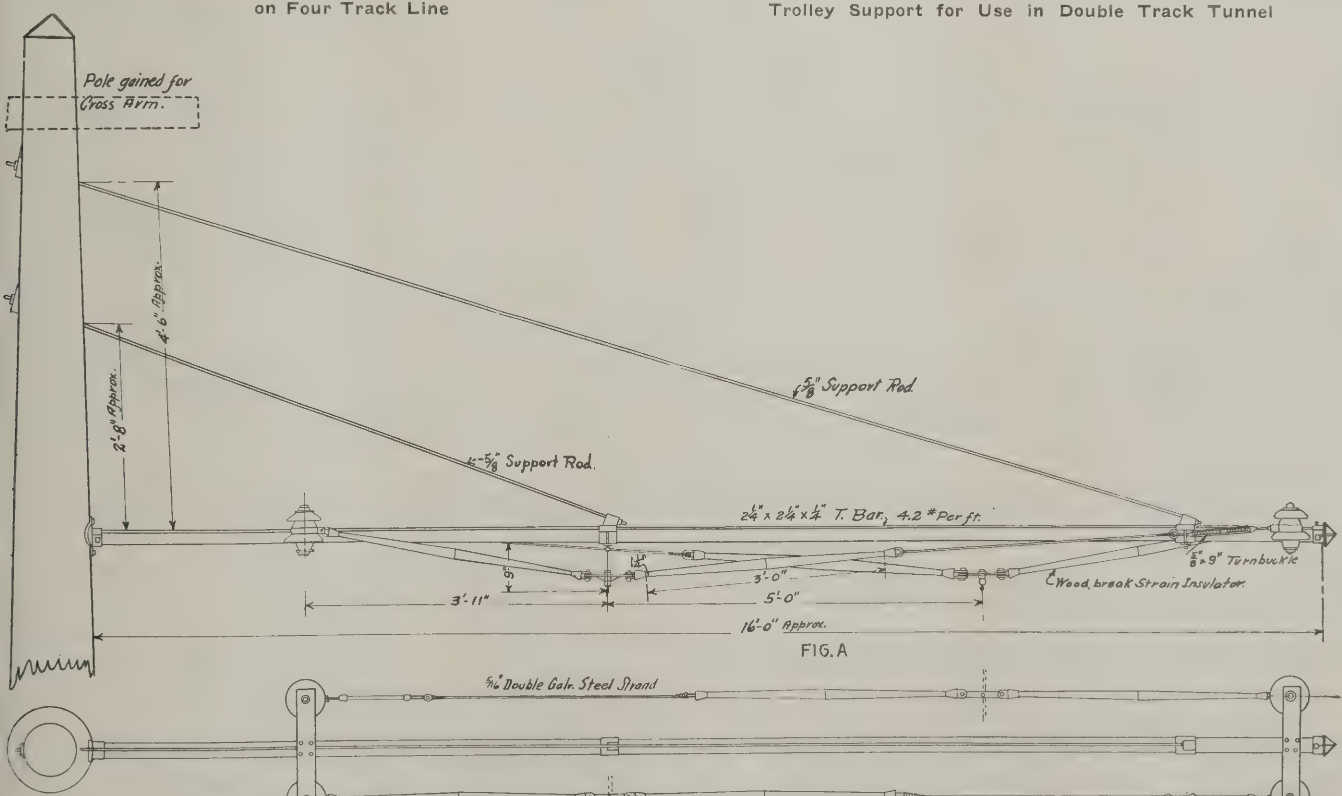
Cross Catenary Construction for Yards Suitable for Spanning Four Tracks or More



Bridge for Carrying Catenary Feeder, Control and Signal Wires on Four Track Line

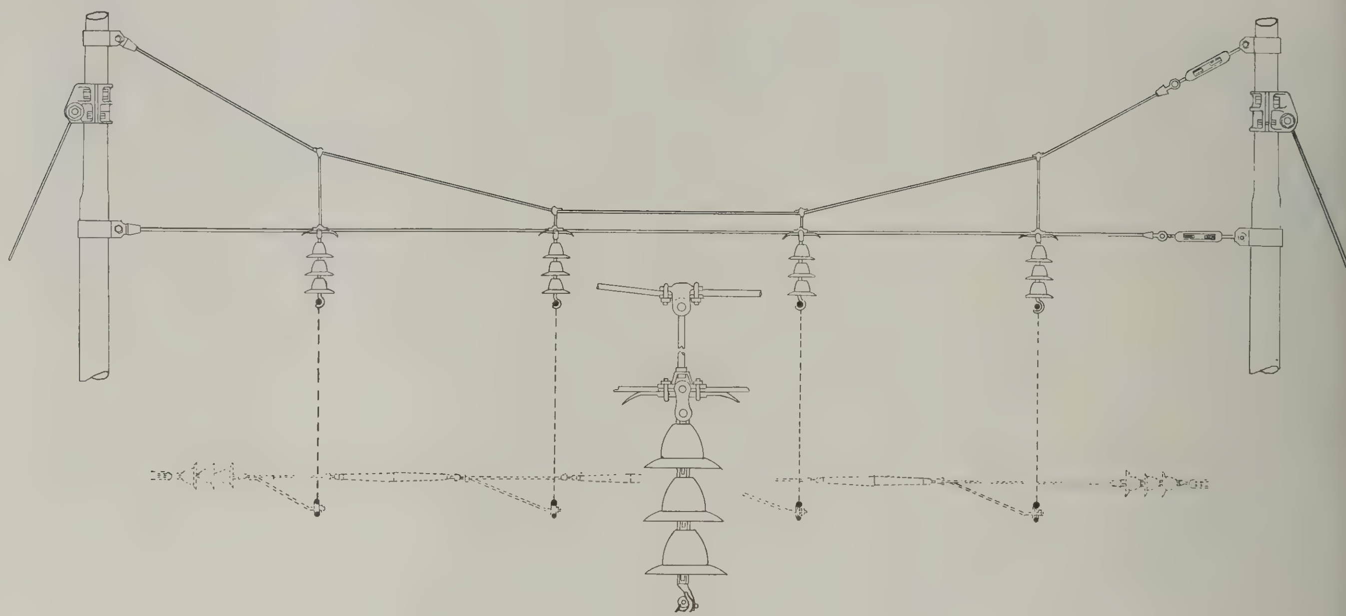


Trolley Support for Use in Double Track Tunnel

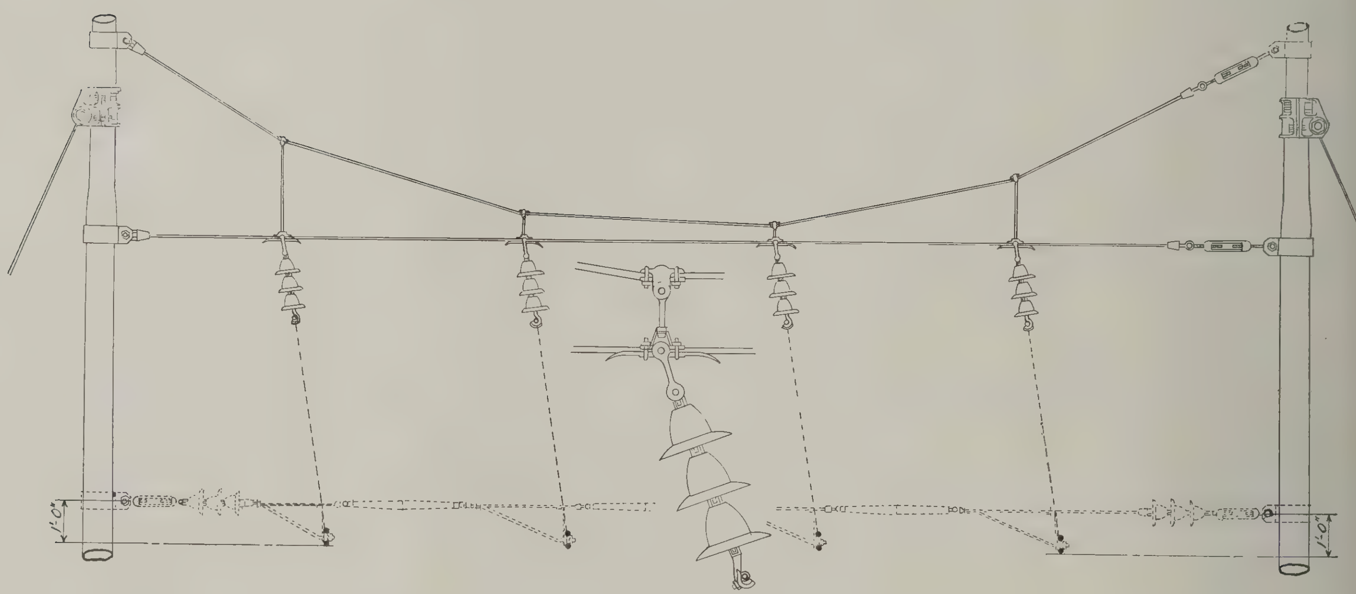


TOP VIEW

Bracket Arm Trolley Support

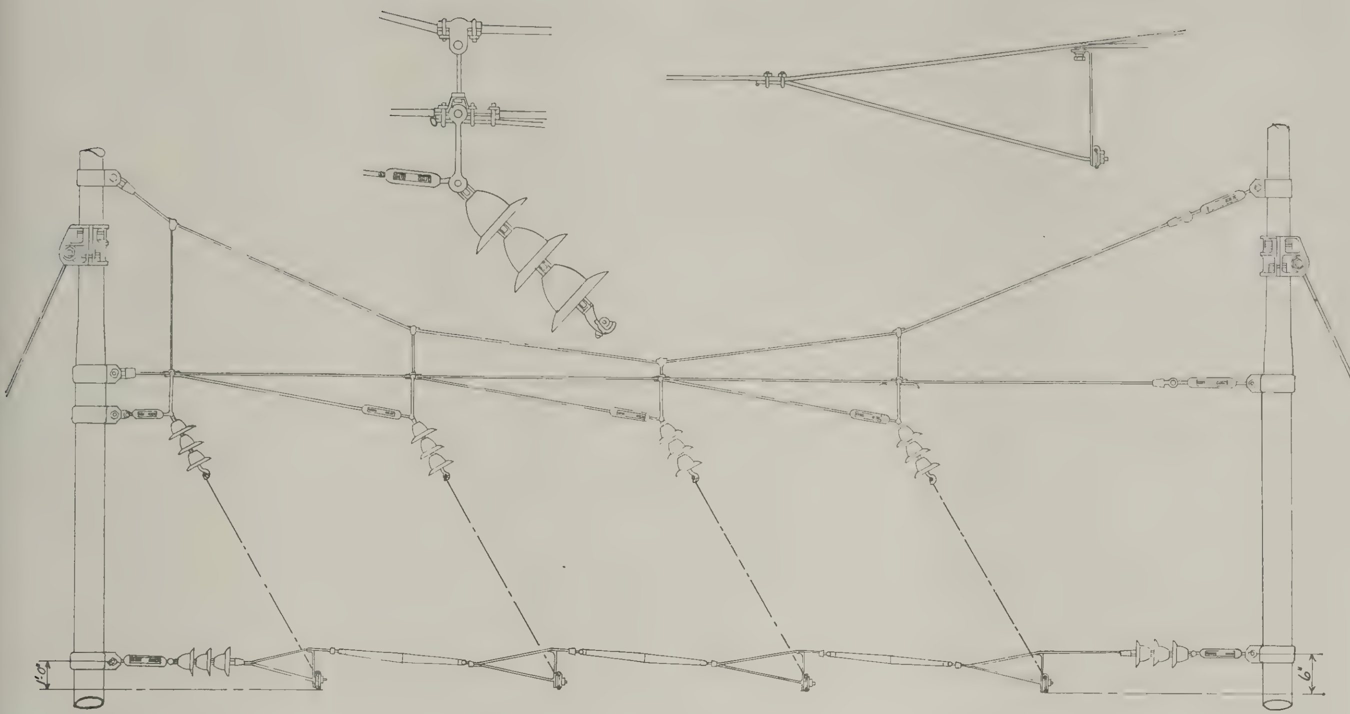


Cross Catenary Construction for Tangent Track

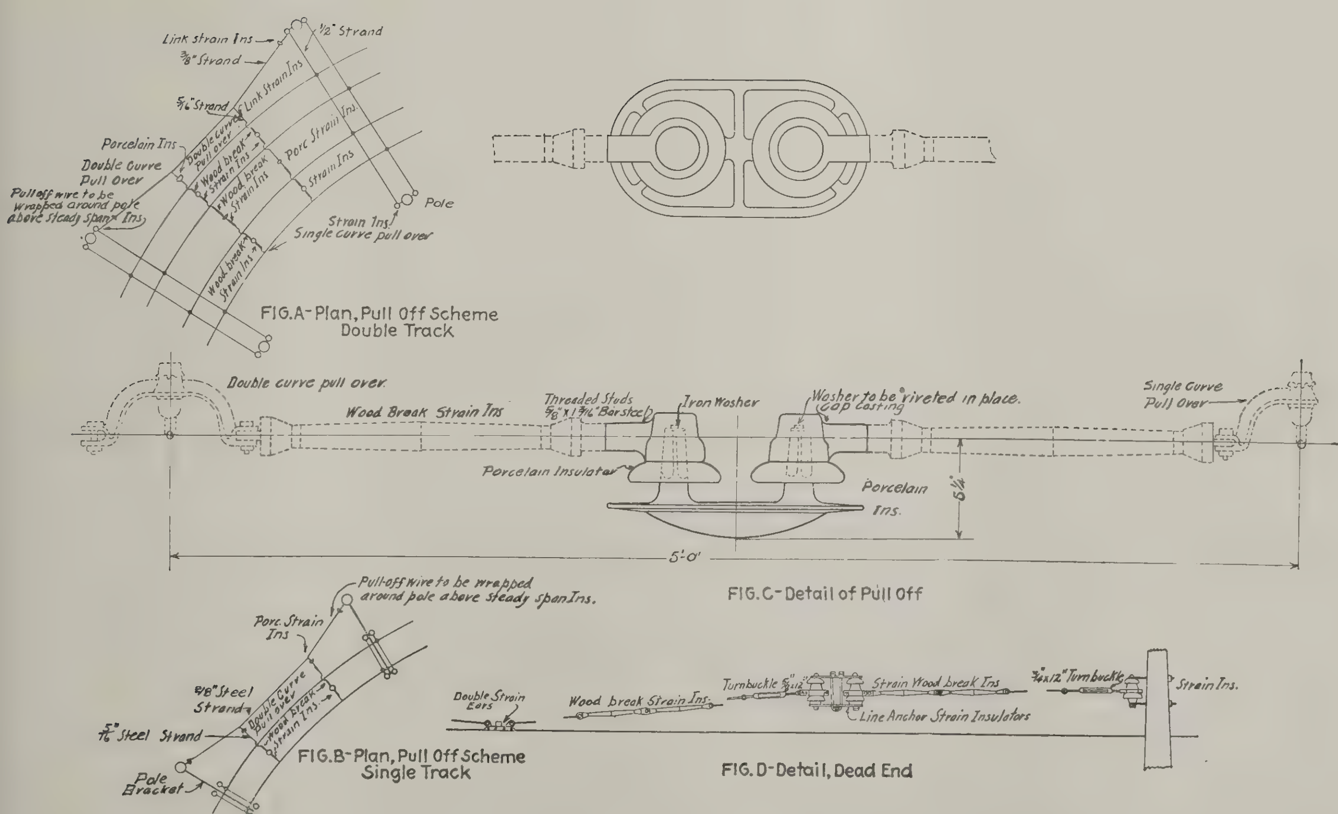


Cross Catenary Construction for Low Curve Less Than 0 Deg. 40 Min.

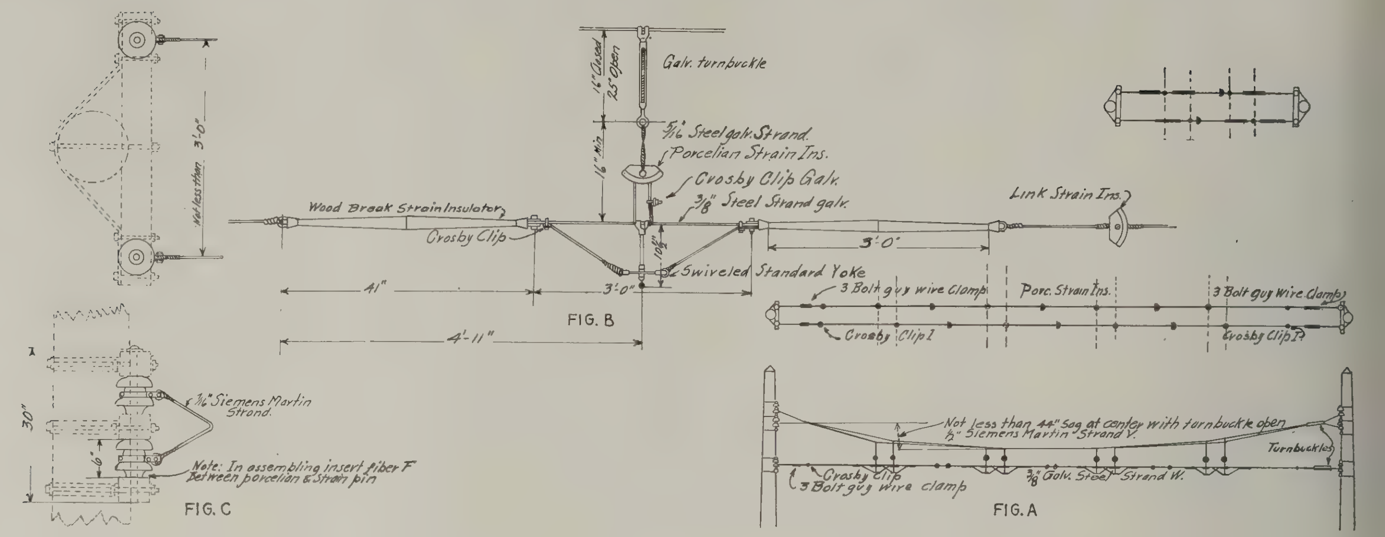
Cross Catenary Construction for Intermediate Curve of More Than 0 Deg. 40 Min. and Less Than 1 Deg. 40 Min.



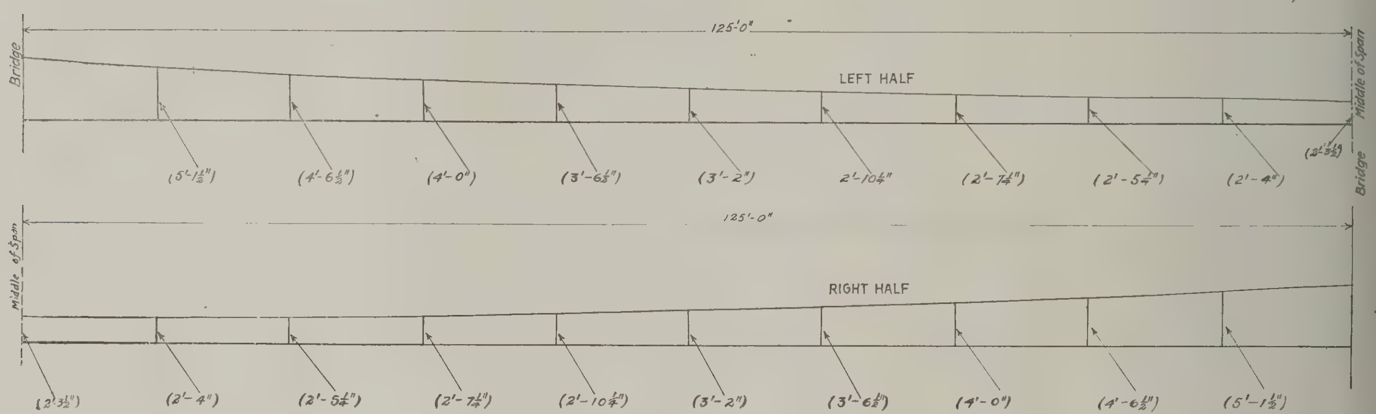
Cross Catenary Construction for High Curves of More Than 1 Deg. 40 Min. Radius



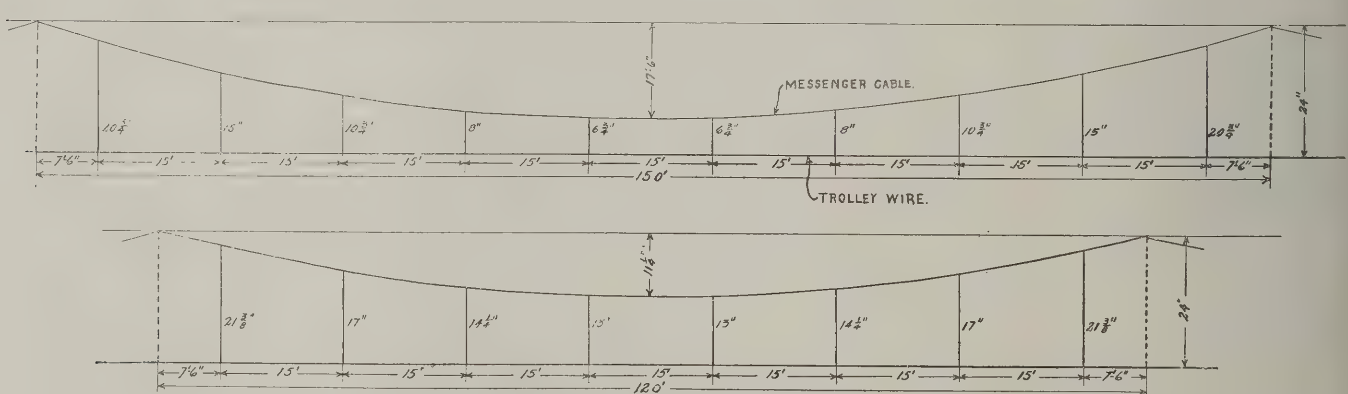
Details for Pull-offs and Dead End



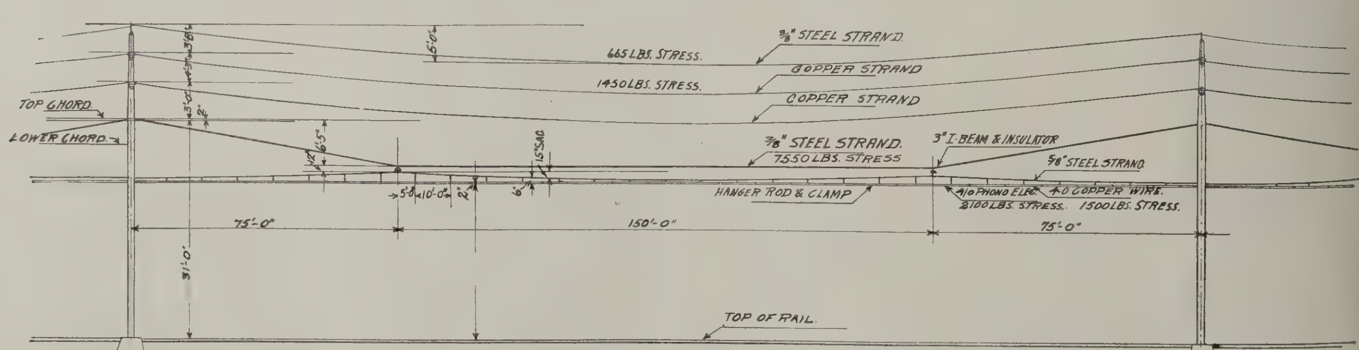
Details of Cross Catenary Construction



Catenary Design for 250 Ft. Span



Catenary Design for 150 Ft. and 120 Ft. Spans



Sags and Stresses for Catenary and Transmission Lines at 60 Degrees F.

(*Continued from page* 333)

With this recommendation your Committee is in hearty accord, and it is hoped that suitable action to bring about this result will be taken, both by our Association and by the other organizations interested.

In order to proceed on some logical basis, a definition of Heavy Electric Traction was desired; that is, how heavy must a locomotive be and how many cars must be operated in a train to merit being considered as Heavy Traction.

It was finally decided that this term should only be applied when the locomotive weighed 80 tons or more and four or more multiple unit cars were normally operated in one train.

Your Committee's report for this year consists essentially of the data presented in the 1920 report, which has been checked and corrected by the various Railroads and revised on the above basis and extended to include all such electrifications in both North and South America. They also present corresponding data relative multiple unit equipment.

Your Committee is indebted to the Heavy Traction Committee of the A. E. R. A. for this latter data and hereby desires to acknowledge and thank this Committee for their courtesy in the matter.

Your Committee also presents drawing showing typical third rail and trolley construction.

Respectfully submitted,

COMMITTEE ON HEAVY ELECTRIC TRACTION.

Data on Heavy Electric Traction in the Americas

General

Railroad	Section electrified	Character of service	Specific cause of electrification	Began electrical operation	Miles: Route	Main line	Yards and sidings	Total single track	System of electrification
*Baltimore & O..	Baltimore Tunnel.	Heavy passenger and freight.	Tunnel and terminal.	1895	3.6	.....	.....	7.96	600 volts, d.c.
*Boston & Maine.	Hoosac Tunnel, N. Adams, Mass.	Heavy passenger and freight.	Tunnel	May, 1911	7.92	15.84	5.47	21.31	11,000 volts, 1 ϕ, 25 ~.
*Butte, Anaconda & Pacific.	Butte, Anaconda, Mont.	Heavy passenger and freight.	General economy.	May, 1913	25.30	25.30	97.00	122.30	2,400 volts, d.c.
*Chic., Milwaukee & St. Paul.	Harlowton, Avery, Mont.	Heavy passenger and freight.	General economy.	December, 1915	437.6	437.6	141.9	579.5	3,000 volts, d.c.
*Chic., Milwaukee & St. Paul.	Othello — Seattle, Tacoma, Wash.	Heavy passenger and freight.	General economy.	August, 1919	209.1	212.1	68.8	280.9	3,000 volts, d.c.
*Erie	Rochester — Mt. Morris, N. Y.	M.v. passenger and freight.	.....	June, 1907	34.	34.	4.	38.	11,000 volts, 1 ϕ, 25 ~.
*Grand Trunk....	Port Huron, Mich. —Sarnia, Ontario.	Heavy passenger and freight.	Tunnel	May, 1908	3.8	6.5	5.5	12.	3,300 volts, 1 ϕ, 25 ~.
*Great Northern..	Cascade Tunnel, Wash.	Helper.	Tunnel	July, 1909	3.5	.....	2.5	.....	6,600 v., 3 ϕ, 25 ~ dbl. trolley.
*Long Island ...	Sub'rb'n lines from Brooklyn and New York, N. Y.	Suburban pass'ng'r.	Tunnel and terminal.	June, 1905	86.5	197.6	29.6	227.2	600 volts, d.c.
Michigan Central.	Detroit River Tun., Detroit, Mich.— Windsor, Canada.	Heavy passenger and freight.	Tunnel and terminal.	1910	6.25	.....	.....	24.	600 volts, d.c.
New York Cent'l.	New York—Harmon, N. Y.	Heavy and suburban passenger.	Tunnel and terminal.	1906	34.	.....	.....	268.	600 volts, d.c.
N. Y. Connecting.	Over East River, New York, N. Y.	Heavy passenger and freight.	Connecting P. R. R. and N. Y., N. H. & H.	1918	5.5	.....	.....	11.	11,000 volts, a.c., 1 ϕ, 25 ~.
*New York, New Haven & Hartf'd.	New York, N. Y. —New Haven, Conn.	Heavy passenger and freight.	Terminal and general economy.	July, 1907	83.2	333.0	186.0	519.0	11,000 volts, 1 ϕ, 25 ~.
*New York, Westchester & Boston.	Harlem River, White Plains, Larchmont, N. Y.	Suburban pass'ng'r.	.....	1912	22.72	59.74	4.30	64.04	11,000 volts a.c., 1 ϕ, 25 ~.
*Norf'k & West'n.	Bluefield — Vivian, W. Va.	Heavy freight....	Grade and general economy.	1914	30.	.....	.....	108.26	11,000 volts, 1 ϕ, 25 ~.
*Oregon Electric..	Portland—Eugene, Oregon. Portland — Forest Grove, Oregon.	Passenger and freight.	.....	1912	122. / 27.	..... /	..... /	..... /	1,200 volts, d.c.
*Pennsyl. System.	Sunnyside Yard, L'g Island—Manhattan Trans. N. J.	Heavy passenger.	Tunnel and terminal.	1910	13.5	.....	.....	110.0	675 volts, d.c.
*Pennsyl. System.	Philadelphia, Paoli, Chestnut Hill, Pa.	Suburban pass'ng'r.	Term. congestion and economy.	Paoli, Sept., 1915; Chestnut Hill, Apr., 1918	30.0	.....	.....	117.28	11,000 volts, 1 ϕ, 25 ~.
Pennsyl. System..	Camden, Millville, Atlantic City, N. J.	Passenger—express and local	Economy.	1906	75.	.....	.....	150.38	600 volts, d.c.
*South'n Pac.—T. Portland Div's'n.	Portland, Corvallis.	Interurban pass...	.....	January, 1914	146.	147.	.....	162.	1,500 volts, d.c.
Oakl'd, Alameda & Berkley.	Berkley—Alameda, Oakland, Cal.	Suburban	.....	June, 1911	52.25	100.81	14.	114.81	1,200 volts, d.c.
Spokane & Inland.	Spokane, Moscow & Cœur d'Alene.	Passenger and freight.	.....	.....	127	129.5	1.5	131.	6,600 volts, a.c., 1 ϕ, 25 ~.
*Visalia Electric..	Visalia — Lemon Cove, Elderwood, Cal.	Passenger and freight.	Economy.	March, 1908	.....	31.4	7.9	39.3	3,300 volts, 1 ϕ, 15 ~.
*Canadian Nat'l..	Montreal, Canada.	Heavy passenger.	Tunnel and terminal.	October, 1918	8.	13.	8.	17.	2,480 volts, d.c.
Paulista	Campinas, Jundiahy, Brazil.	Passenger and freight.	Economy — coal mostly imported.	1921	23.5	.....	.....	.....	3,000 volts, d.c.

*Data given in 1920 report corrected and extended by railroad.

Power Generation

Railroad	Power Supply: Chief Source	Generated or Purchased	Prime Movers: No.	Mfg.	Rating	Voltage	Current	Phases	Cycles	Per cent power Regenerated
*Baltimore & Ohio	Con. Gas, Elec. Light & Power Co.	Purchased	.....	.....	.....	.....	.....	.....	.....	0.00
*Boston & Maine	New England Power Co.	Purchased	.....	.....	.....	11,000 v.,	a.c.,	3 ϕ	25 ~.	0.00
*Butte, Anaconda & Pacific	Great Falls Power Co., hydro-electric.	Purchased	.....	.....	.....	.....	.....	.....	.....	0.00
*Chicago, Milwaukee & St. Paul	Montana Power Co. & Thompson Falls Power Co.	Purchased	.....	.....	.....	6,600 v.	.....	.....	.....	10-11
*Chicago, Milwaukee & St. Paul	Wash. Water Power Co.—Puget Sound T., L. & P.	Purchased	.....	.....	.....	.....	.....	.....	.....	10-11

*Erie	Niagara, Lockport & Ont. P. Co.	Purchased	....	....	0.00
*Grand Trunk	Detroit Edison Co.	Purchased	....	....	
	Grand Tr. Ry. Co. Power Plant	Generated	2 W. E. & Mfg. Co., 1,250 kw. turbos,	3,300 v., a.c., 3 ϕ, 25 ~	0.00
*Great Northern	Hydro-Electric	Generated	2 .... 2,500 k. v. a. hydraulic turb. gen.	6,600 v., a.c., 3 ϕ, 35 ~	....
*Long Island	Penna. R. R. Long Island P. P.	Purchased	See Pennsylvania System	11,000 v., a.c., 3 ϕ, 25 ~	0.00
Michigan Central	Detroit Edison	Purchased	....	....	0.00
New York Central & Hud. River	N. Y. C. Power Plants, Port Morris & Glenwood.	Generated	G. E. turbines, total cap. 60,000 kw	....	0.00
New York Connecting	N. Y., N. H. & H. R. R. Cos Cob Power Plant.	Purchased	....	11,000 v., a.c., 3 ϕ, 25 ~	0.00
*N. Y., N. H. & Hartford	N. Y., N. H. & H. R. R. Cos Cob Power Plant.	Generated	3 W. E. & Mfg. Co. turbo-gen., 3,750 k. v. a. 4 W. E. & Mfg. Co. turbo-gen., 5,000 k. v. a. 1 W. E. & Mfg. Co. turbo-gen., 4,200 k. v. a.	11,000 v., a.c., 3 ϕ, 25 ~	0.00
*N. Y., Westchester & Boston	N. Y., N. H. & H. R. R. Cos Cob Power Plant.	Purchased	See N. Y., N. H. & H.	11,000 v., a.c., 3 ϕ, 25 ~	0.00
*Norfolk & Western	N. & W. R. R. Blue Stone Power Plant.	Generated	4 W. E. & Mfg. turbo-gen., 10,000 kw.	11,000 v., a.c., 3 ϕ, 25 ~	....
*Oregon Electric	Portland Ry. Lt. & P. Co.	Purchased	....	11,000 v., a.c., 3 ϕ, 33 ~	0.00
*Pennsylvania System—N. Y.	Penn. R. R. Long Is. Power Plant	Generated	2 W. E. & Mfg. Co. turbo-gen., 5,500 kw. 2 W. E. & Mfg. Co. turbo-gen., 8,000 kw. 2 W. E. & Mfg. Co. turbo-gen., 20,000 kw.	11,000 v., a.c., 3 ϕ, 25 ~	0.00
*Pennsylvania System—Paoli	Philadelphia Electric Co.	Purchased	....	13,200 v., a.c., 3 ϕ, 25 ~	0.00
Penna System—Atlantic City	Penn. R. R. Co., Westville P. P.	Generated	4 G. E. 2,000 kw. surbo-gen.	6,600 v., a.c., 3 ϕ, 25 ~	0.00
*Southern Pacific					
Portland Division	Portland Ry., Lt., and Power Co.	Purchased			
Oakland, Alameda & Berkeley	Fruitvale Pwr. Plant of O. A. & B.	Generated	2 W. E. & Mfg. Co. turbo-gen., 7,500 kw.	13,200 v., a.c., 3 ϕ, 25 ~	0.00
Spokane & Inland					
*Visalia Electric	Southern California Edison Co.	Purchased	....	....	0.00
*Canadian National	Part of Hydro-Electric net work.	Purchased	....	....	0.00
Paulista	Sao Paulo Light & Power Co.	Purchased	Hydro-electric	88,000 v., a.c., 3 ϕ, 60 ~	....

*Data given in 1920 report corrected and extended by Railroad.

Power Distribution

Railroad	Third rail construction: Miles, Route	Miles, Track	Size, rail	On — side	Gage line running rail to gage line 3rd rail: Horizontal	Vertical	Bonds, c.m.	Overhead construction: Miles, Route	Miles, Total	Messenger: Type	Messenger: Material	Messenger: Size	Auxiliary messenger: Material	Auxiliary messenger: Size
*Baltimore & Ohio	3.6	7.96	70 & 100	Top	2′ 5 9/16″	3½″	400,000	....	....	....	....	....	....	....
*Boston & Maine	....	....	....	....	....	....	....	7.92	21.31	[1]Single catenary [2]Single catenary	Steel Copper	⅝″ ⅝″	Copper Copper	4/0 1/0
*Butte, Anaconda & Pacific	....	....	....	....	....	....	....	25.30	122.5	Catenary	Steel	½″	....	....
*[3]Chic., Milwau. & St. Paul	....	....	....	....	....	....	....	437.6	579.5	Single catenary—double trolley	Steel	½″	....	....
*[4]Chic., Milwau. & St. Paul	....	....	....	....	....	....	....	209.1	280.9	Single catenary—double trolley	Steel	½″	....	....
*Erie	....	....	....	....	....	....	....	34.	38.	Single catenary	Steel	7/16″	Copper	3/0
*Grand Trunk	....	....	....	....	....	....	....	3.8	12.	Single catenary	Steel	9/16″ to ⅝″	....	....
*Great Northern	....	....	....	....	....	....	....	....	....	Cross catenary—double trolley	....	....	....	....
*Long Island	86.50	227.2	100 & 150	Top	2′ 2″	3½″	Various	4.1	....	....	....	....	....	....
Michigan Central	....	....	....	....	....	....	....	....	....	....	....	....	....	....
N. Y. Cent. & Hudson River	....	....	70	Under	2′ 2 15/16″	2¾″	....	....	....	....	....	....	....	....
*New York Connecting	....	....	....	....	....	....	....	4.7	11.6	Catenary	Steel	9/16″	Copper	2/0
*N. Y., N. H. & Hartford	....	....	....	....	....	....	....	[5]22.9	91.	Double catenary	Steel	9/16″	....	....
*N. Y., N. H. & Hartford	....	....	....	....	....	....	....	[6]1.1	4.5	Compound cat'n'y	Steel	1¼ only 2	Steel	⅝″
*N. Y., N. H. & Hartford	....	....	....	....	....	....	....	[7]34.9	141.5	Compound cat'n'y	Steel	⅞″	Steel	⅝″
*N. Y., N. H. & Hartford	....	....	....	....	....	....	....	[8]10.8	22.6	Single catenary	Steel	⅝″	....	....
*N. Y., N. H. & Hartford	....	....	....	....	....	....	....	[9]1.69	7.1	Single catenary	Steel	⅝″	....	....
*N. Y., N. H. & Hartford	....	....	....	....	....	....	....	[10]9.58	57.5	Compound cat'n'y	Steel	⅞″	Steel	⅝″
*N. Y., N. H. & Hartford	....	....	....	....	....	....	....	[11]7.9	7.9	Single catenary	Steel	7/16″	....	....
*N. Y., Westchester & Bos.	....	....	....	....	....	....	....	[12]7.9	31.6	Compound cat'n'y	Steel	⅞″	Steel	⅝″
*N. Y., Westchester & Bos.	....	....	....	....	....	....	....	[13]8.5	17.	Compound cat'n'y	Steel	⅝″	Copper	4/0
*N. Y., Westchester & Bos.	....	....	....	....	....	....	....	2.	4.	Compound cat'n'y	Steel	⅞″	Steel	⅝″
*Norfolk & Western	....	....	....	....	....	....	....	23.	46.	Single catenary	Steel	½″	Steel and Copper	1/0
*Oregon Electric	....	....	....	....	....	....	....	122.	180.	Single catenary	Steel	7/16″	....	....
*[14]Pennsylvania System	....	110	25 & 150	Top	....	....	....	....	....	....	....	....	....	....
[15]Pennsylvania System	....	....	....	....	....	....	....	30.	117.28	Single catenary	Steel	½″	Copper	1/0 rd.
[16]Pennsylvania System	....	141.7	100	Top	2′ 2″	3.5″	2-500,000	....	....	....	....	....	....	....
*South'n Pac., Portland Div.	....	....	....	....	....	....	....	146.	162.	Single catenary	Steel	7/16″	....	....
*Southern Pacific (Oakland, Alameda & B.).	....	....	....	....	....	....	....	52.25	114.81	Single catenary	Steel	7/16″	....	....
*Visalia Electric	....	....	....	....	....	....	....	22.	45.	Single catenary	Steel	7/16″	....	....
*Canadian National	....	....	....	....	....	....	....	9.	10.	Catenary	Steel Phosphor-bronze	½″ ⅞″	....	....

*Data given in 1920 report corrected and extended by railroad. [1]Outside of tunnel. [2]Inside tunnel. [3]Harlowton—Avery. [4]Othello—Seattle—Tacoma. [5]Woodlawn—New Rochelle—Stamford. [6]Stamford—Glenbrook. [7]Glenbrook—New Haven.

Power Transmission

Railroad	Number circuits	Conductors: Size	Conductors: Material	Conductors: Spacing	Conductors: Av. span	Insulators: Make	Insulators: Type	Poles, material	Voltage	Current	Phases	Cycles
*Baltimore & Ohio........	..	....	....	......	......	......	......	......	......	...	...	..
*Boston & Maine..........	2	4/0	Copper	......	100 ft.	Locke	603, 80,405	Wood	11,000	a.c.	1 φ	25
*Butte, Anaconda & Pacific	..	....	....	......	......	......	......	......	......	...	...	..
*[1]Chicago, Milwau. & St. P.	1	2/0	Copper	Varies	350 ft.	Various	Suspension	Wood	100,000	a.c.	3 φ	60
*[2]Chicago, Milwau. & St. P.	1	2/0 & 1/0	Copper	Varies	350 ft.	Various	Suspension	Wood	100,000	a.c.	3 φ	60
*Erie	..	....	....	......	......	......	......	......	60,000	a.c.	3 φ	25
*Grand Trunk............	..	4/0 & 300,000 c.m.	Copper	......	......	......	......	......	......	...	...	..
*Great Northern..........	2	No. 2	Copper	5' 10" hor. 3' 6" vert.	......	......	......	Wood	33,000	a.c.	3 φ	25
*Long Island.............	1-10	2/0 250,000 c.m. 350,000 c.m.	Copper	24"	150 ft.	Various	Pin	Steel & wood	11,000	a.c.	3 φ	25
Michigan Central..........	..	....	....	......	......	......	......	......	......	...	...	..
N. Y. C. & Hudson River	..	....	....	......	......	......	......	......	......	...	...	..
New York Connecting......	..	....	....	......	......	......	......	......	......	...	...	..
*N. Y. N. H. & Hartford.	4	4/0	Copper	......	300 ft.	Ohio Brass	Pin & Susp'n	Steel bridges	22,000	a.c.	1 φ	25
*N. Y. W. Chester & Boston	4	4/0	Copper	3' 1" hor. 5' 0" vert.	300-400 ft.	......	......	Steel bridges	22,000	a.c.	1 φ	25
*Norfolk & Western.......	2	2/0	Copper	......	300 ft.	......	......	Steel bridges	44,000	a.c.	1 φ	25
*Oregon Electric..........	1	105,530 c.m.	Aluminum	6' 0" △	150 ft.	Thomas	Pin	Wood	60.000	a.c.	1 φ	33
*[3]Pennsylvania System......	..	250,000 c.m.	Copper	3 cond. lead	Underground	......	......	......	11,000	a.c.	3 φ	25
*[4]Pennsylvania System......	4	2/0	Copper	5' 0" hor. 3' 6" vert.	......	......	......	......	44,000	a.c.	2-1 φ	25
[5]Pennsylvania System.......	2	No. 1	Copper	42" △	125 ft.	......	......	Wood	33,000	a.c.	3 φ	25
South'n Pac. Portland Div.	2	1/0	Copper	3' 0"	150 ft.	Ohio Brass	9,410	Steel & wood	13,200	a.c.	3 φ	60
	1	No. 4	Copper	6' 0"	......	Locke	341	......	55,000	a.c.	3 φ	60
Southern Pacific (Oakland Alameda & B)	2	1/0	Copper	3' 0" hor.	......	......	......	Steel	13,200	a.c.	3 φ	25
Spokane & Inland.........	..	......	......	......	......	......	......	......	......	...	...	..
*Visalia Electric	2	4	Copper	......	120 ft.	......	......	Trolley poles	11,000	a.c.	1 φ	15
*Canadian National.........	5	4/0	Copper	......	150 ft.	Locke	408	Cedar	2,400	d.c.	...	..
Paulista	2	1/0	Copper	......	......	......	......	H poles wood	88,000	a.c.	3 φ	60

*Data given in 1920 report corrected and extended by railroad.
[1]Harlowton—Avery.
[2]Othello—Seattle—Tacoma.
[3]Manhattan Transfer through New York station to Sunnyside yards.
[4]Broad Street station, Philadelphia, to Paoli and Chestnut Hill.
[5]Camden to Atlantic City and Millville.

Power Distribution

Overhead construction: Contact wire: Material	Size	Height above rail: Normal	Max.	Min.	Type of support	Spacing	Av. distance between anchor bridges	Return current through	Feeders: Positive	Feeders: Negative	Track bonds
......	....	.....	.....	.....	......	....	.....	Rails	....	.....	400,000 c.m.
Phono-electric	4/0	22' 0"	23' 0"	19' 5"	Steel bridges	150'	.....	Rails	....	.....	2-4/0
Phono-electric	2-4/0	15' 10"	16' 7"	15' 10"	Brackets	100'	.....	Rails	....	.....	......
Copper	4/0	22' 4"	25' 0"	17' 4"	Wood	150'	.....	Rails	600,000 c.m. main line	1-4/0	4/0
Copper	Main 2-4/0 Siding 1-4/0	24' 2"	26' 0"	17' 0"	Wood	150'	1 mile	Rails	Size varies	1-4/0 supplementary	Single & double, pin, 250,000 c.m.
Copper	Main 2-4/0 Siding 1-4/0	24' 2"	26' 0"	17' 0"	Wood	150'	1 mile	Rails	Size varies	1-4/0 supplementary	Single & double, pin, 250,000 c.m.
Steel	3/0	21' 0"	.....	18' 0"	Steel & wood	120'	.....	Rails	....	.....	......
Copper	4/0 & 300,000 c.m.	22' 0"	.....	.....	Steel bridges Brackets	250' 12'	.....	Rails	....	.....	4/0 and 2-300,000 c.m.
......	....	24' high, 5' apart	.....	.....	Wood	100'	1,000	Rails	....	.....	1-4/0
......	....	.....	.....	.....	....	....	.....	Rails	....	.....	......
......	....	.....	.....	.....	....	....	.....	Rails	....	.....	......
......	....	.....	.....	.....	....	....	.....	Rails	....	.....	......
Phono-electric	3/0	22' 0"	22' 0"	17' 6"	Steel	....	.....	Rail	....	.....	1/0 Duplex
Steel & phono-electric	4/0	22' 0"	22' 0"	15' 4½"	Steel bridges	300'	2.6 miles	3rd wire & rail	New Rochelle—Woodlawn, 2-4/0, 2-2/0 New Rachelle—Stamford, 4-4/0	.....	4/0 Flexible
Steel & phono-electric	4/0	20' 10"	22' 0"	18' 0"	Steel	300'	.....	3rd wire & rail	4-4/0	.....	1/0 Duplex
Steel & phono-electric	4/0	20' 10"	22' 0"	15' 8"	Steel bridges	300'	4.2 miles	3rd wire & rail	4-4/0	.....	1/0 Duplex
Steel & phono-electric	4/0	20' 10"	22' 0"	15' 10½"	Steel bridges	300'	2.6 miles	3rd wire & rail	4-4/0	.....	1/0 Duplex
Steel & phono-electric	4/0	20' 10"	22' 0"	18' 5"	Steel	300'	1.1 miles	3rd wire & rail	4-4/0	.....	1/0 Duplex
Steel & phono-electric	4/0	20' 10"	22' 0"	16' 0"	Steel bridges	300'	2.4 miles	3rd wire & rail	4-4/0	.....	1/0 Duplex
Steel	4/0	22' 0"	22' 0"	22' 0"	Wood & steel	150'	.....	Rail	....	.....	4/0 Flexible
Steel	4/0	.....	.....	.....	Steel bridge	300'	.....	3rd wire	4-4/0	.....	Pin terminal
Phono-electric	4/0	22' 0"	.....	.....	Steel bridge	300'	.....	3rd wire	2-4/0	.....	Pin terminal
Steel	4/0	.....	.....	.....	Steel bridge	300'	.....	3rd wire	3-4/0 22,000 v. 1-4/0 11,000 v.	.....	Pin terminal
Phono-electric	3/0 grooved	23' 9"	.....	16' 0"	Steel bridges	300'	.....	Rails	....	.....	Equivalent .275" rd.
Copper	3/0 grooved	21' 0"	23' 0"	17' 0"	Wood	150'	1 mile	Rails	300.000 c.m.	.....	4/0 welded
......	....	.....	.....	.....	....	....	.....	Rails	....	.....	......
Phono-electric	3/0	22' 0"	.....	.....	Tubular steel	300'	½ mile	Rails	....	.....	......
......	....	.....	.....	.....	....	....	.....	Rails	....	.....	2-400,000 c.m.
Copper	4/0	22' 0"	.....	.....	Cedar	150'	.....	Rails	Alum. 336,420 c.m. 636,000 c.m.	.....	4/0
Copper	4/0	22' 0"	.....	.....	Steel bridges and poles	240' 120'	.....	Rails	Alum. 1,590,000 c.m. 1,192,000 c.m. 800,000 c.m.	.....	4/0 double
Copper	3/0	22' 0"	.....	.....	Red wood Cedar	120' 150'	.....	Rails	....	.....	2-1/0
Copper Phono-electric	4/0 4/0	22' 6"	22' 6"	16' 0"	Cedar	150'	.....	Rails	4/0	.....	4/0 welded

[8]Glenbrook—New Haven. [9]Harlem River Branch. [10]Harlem River Branch. [11]New Canaan Branch. [12]Maine line. [13]White Plains Branch. [14]Manhattan Transfer through New York station to Sunny Side yard. [15]Broad Street Station, Philadelphia—Paoli and Chestnut Hill. [16]Camden—Atlantic City and Millville.

Data on Heavy Electric Traction in the Americas

Sub-Stations

Railroad	Number	Type	Spacing miles	Transformers				Rotary Converters			Motor Generators			Transformed to			
				Number	Type	Rating	Ratio	Number	Type	Rating	Number	Type	Rating	Voltage	Current	Phase	Cycle
*Baltimore & Ohio	3	Rotary converter.	....	..	....	....	....	4	G. E.	3-1,000 kw. 1-2,000 kw.	.....	....	....	600	d.c.	..	..
*Boston & Maine	3	Switching	....	..	....	....	....	..	.....	....	.....	....	....	.....	...	..	..
*Butte, Anaconda & Pacific	2	Motor generator.	26	..	O. I. W. C., 1 φ	2,400 k.v.a.	100,000-2,400	..	.....	....	7 G. E.	1,200-24,005 3 unit syn. motor	1,000 kw.	2,400	d.c.	..	..
*[1]Chic., Milwau. & St. Paul	14	Attended motor generator.	32.7 av.	9 △ △ 23 △ △	G. E. Co., O. I. S. C., 3 φ 60 ~. G. E. Co., O. I. S. C., 3 φ 60 ~.	1,900 k.v.a. 2,500 k.v.a.	102,000 {2,300 / 1,150} 102,000 {2,300 / 1,150}	.. ..	....	....	9 G. E. 23 G. E.	3 unit syn. motor 3 unit syn. motor	1,500 kw. 2,000 kw.	3,000 3,000	d.c. d.c.	.. ..	.. ..
*[2]Chic., Milwau. & St. Paul	5 & 3	Attended motor generator.	28 av.	9 Y △ 6 Y △	G. E. Co., O. I. S. C., 3 φ 60 ~. West., O. I. S. C., 3 φ 60 ~.	2,500 k.v.a.	102,000 {2,300 / 1,150}	..	.....	....	8 G. E. 6 West.	3 unit syn. motor 3 unit syn. motor	2,000 kw. 2,000 kw.	3,000 3,000	d.c. d.c.	.. ..	.. ..
*Erie	1	Transformer	....	3	O. I. W. L., 1 φ	750 k.v.a.	60,000-11,000	..	.....	....	.....	....	....	11,000	a.c.	1	25
*Grand Trunk	..	....	....	..	....	....	....	..	.....	....	.....	....	....	.....	...	..	..
*Great Northern	1	Transformer	....	4	....	833 kw.	33,000-6,600	..	.....	....	.....	....	....	6,600	a.c.	3 φ	25
*Long Island	[3]14	Rotary converter.	3 to 8	..	....	....	....	45	West.	1,000-1,500 kw.	.....	....	....	650	d.c.	..	..
*Long Island	[4]3	Rotary converter.	....	..	....	....	....	..	.....	2,000-3,000 kw.	.....	....	....	650	d.c.	..	..
Michigan Central	1	Rotary converter.	....	..	....	....	....	2	G. E.	....	.....	....	1,000 kw.	600	d.c.	..	..
N. Y. Cent. & H'ds'n River	..	Rotary converter.	....	..	....	....	....	..	G. E. West.	20,000 kw. 245,000 kw.	.....	....	....	600	d.c.	..	..
New York Connecting	..	....	....	..	....	....	....	..	.....	....	.....	....	....	.....	...	..	..
*N. Y., N. H. & Hartford	22	Transformer, remote.	3.87	1	Auto. O. I. S. C., 1 φ	2,000 k.v.a.	22,000-11,000	..	.....	....	.....	....	....	11,000	a.c.	1	25
*N. Y., Westchester & Bos.	3	Transformer	9.	3	Auto. O. I. S. C., 1 φ	2,000 k.v.a.	22,000-11,000	..	.....	....	.....	....	....	11,000	a.c.	1	25
*Norfolk & Western	5	Transformer	....	12	O. I. W. C., 1 φ	4-2,000 k.v.a. 6-3,000 k.v.a. 2-5,000 k.v.a.	44,000-11,000	..	.....	....	.....	....	....	11,000	a.c.	1	25
*Oregon Electric	[9]9	Rotary converter.	20	36	8-1 φ, 1-3 φ	185 k.v.a.	60,000-11,000	13	G. E.	500 kw.	.....	....	....	1,200	d.c.	..	..
*[5]Pennsylvania System	4	Rotary converter.	....	36	A. B.	750 k.v.a.	....	12	West.	2,000 kw.	.....	....	....	600	d.c.	..	..
*[6]Pennsylvania System	6	Transformer, remote.	....	12	1 φ	6-2,000 k.v.a. 6-3,000 k.v.a.	44,000-11,000 44,000-11,000	.. ..	....	....	....	....	....	11,000 11,000	a.c. a.c.	1 1	25 25
[7]Pennsylvania System	8	Rotary converter.	3.6 to 12.5	[8]66	A. B.	12-185 kw. 36-275 kw. 18-370 kw.	....	22	G. E.	4-500 kw. 12-750 kw. 6-1,000 kw.	.....	....	....	675	d.c.	..	..
*South'n Pac.—Portl'd Div.	..	Motor generator and converter.	25	..	....	....	....	2	West. 2 unit	1,000 kw.	7	2 unit syn. motor	500 kw.	1,500	d.c.	..	..
*Southern Pacific (Oakland, Alameda & Berkly).	3	Rotary converter.	10	..	....	....	....	10	G. E. 2 unit	1,500 kw.	.....	....	....	1,200	d.c.	..	..
Spokane & Inland	..	....	....	..	....	....	....	..	.....	....	.....	....	....	.....	...	..	..
*Visalia Electric	5	Transformer	....	5	O. I. S. C.	300 k.v.a.	11,000-3,300	..	.....	....	.....	....	....	3,300	a.c.	1	15
*Canadian National	..	....	....	..	....	....	....	..	.....	....	2 G.E.	1,200-2,400	1,500 kw.	2,400	d.c.	..	..
Paulista	1	Motor generator.	....	3	3 φ 60 ~.	1,900 k.v.a.	88,000-2,300	..	.....	....	3	3 unit syn. motor	1,500 kw.	3,000	d.c.	..	..

*Data given in 1920 report corrected and extended by railroad.
[1]Harlowton—Avery.
[2]Othello—Seattle—Tacoma.
[3]Housed.
[4]Portable.
[5]Manhattan Transfer through New York Station to Sunny Side yard.
[6]Broad Street Station, Philadelphia—Paoli and Chestnut Hill.
[7]Camden—Atlantic City and Millville.
[8]Storage battery reserve.
[9]Eight housed, 1 portable.

ELECTRIC LOCOMOTIVES OF NORTH & SOUTH AMERICA

Company No.	Railroad	Key No.	Series No.	No. in Service	Year Placed in Service	Mfg. Co.	Class of Service	Contact Conductor: Voltage	Contact Conductor: Type	Type of Loco.	Classification by Wheels	Driving Wheels: No.	Driving Wheels: Diam.	Truck Wheels: No.	Truck Wheels: Diam.	Articulated Trucks	Wheel Base: Rigid	Wheel Base: Total
1	Baltimore & Ohio R. R. Co.	1a	6-9	4	1903-06	G-E Co	Frt.	600	3rd. Rail	D. C.	0-4-4-0	8	42 in	0	—	No	14'-6¾	14'-6¾
		1-b	11-12	2	1910	"	Pass-Frt.	600	" "	"	0-4-4-0	8	50 in	0	—	Yes	9'-6	27'-6
		1c	13-14	2	1912	"	" "	600	" "	"	0-4-4-0	8	50 in	0	—	Yes	9'-6	27'-6
2	Bethlehem-Chile Iron Mines Co (South America)	2	6-7-8	3	1920	"	Frt.	2400	3rd Rail & Catenary	"	0-4-4-0	8	52 in	0	—	Yes	11'-0	35'-8
3	Boston & Maine	3-a	5000-4	5	1911	Baldwin WE&MCo	Pass-Frt	11000	Catenary	A.C-1φ	2-4-4-2	8	63 in	4	42 in	Yes	7'-0	38'-6
		3-b	5005-6	2	1917	"	" "	11,000	"	"	2-4-4-2	8	63 in	4	42 in	Yes	7'-0	38'-6
4	Butte Anaconda & Pacific	4-a	39-64	26	1913-17	G.E. Co	Frt.	2400	Catenary	D. C.	0-4-4-0	8	46 in	0	—	Yes	8'-8	26'-0
		4-b	65-6	2	1913	"	Pass	2400	"	"	0-4-4-0	8	46 in	0	—	Yes	8'-8	26'-0
5	Canadian Nat'l Rys (Mt. Royal)	5	600-5	6	1918	GE Co	Pass-Frt	2400	Twin Catenary	D. C.	0-4-4-0	8	46 in	0	—	Yes	8'-8	26'-0
6	Chicago, Milwaukee & St. Paul	6 a	10050-3	4	1917-18	GE Co	Switch.	3,000	Twin Catenary	D. C.	0-4-4-0	8	40 in.	0	—	No	8'-0	30'-4
		6-b	10200-41	42	1916	"	Frt.	3,000	"	"	4-4-4+4-4-4	16	52 in	8	36	Yes (2 Cabs)	10'-6	102'-8
		6-c	10250-4	5	1920	"	Pass.	3,000	"	"	6-8-8-6	24	44 in	4	36 in	Yes	13'-9	67'-0
		6-d	10300	1	1920	Baldwin WE&MCo	Frt.	3000	"	"	4-6-2-2-6-4	12	68 in	12	36 in.	Yes	16'-9	79'-10
		6-e	10301-9	9	1920	"	Pass	3000	"	"	4-6-2-2-6-4	12	68 in.	12	36 in.	Yes	16'-9	79'-10
7	Grand Trunk (St Clair Tunnel)	7	2655-60	3	1908	Baldwin WE&MCo	Pass-Frt	3300	Catenary	A.C. 1φ	0-6-0+0-6-0	12	62 in	0	—	NO (2 Cabs)	16'-0	45'-5½
8	Great Northern Ry.	8	5000-3	4	1909	GE Co	Pass-Frt.	6,600	Direct Suspension	A.C 3φ	0-4-4-0	8	60 in.	0		Yes	11'-0	31'-9
9	Long Island R. R.	9	323	1	1917	WE&MCo	Frt.	650	3rd Rail	D. C.	0-4-4-0	8	56 in	0	—	NO	7'-2	26'-1
10	Michigan Central R. R.	10.a	7500-5	6	1909	GE Co	Pass-Frt	600	3rd Rail	D. C.	0-4-4-0	8	48 in	0	—	Yes	9'-6	27'-6
		10-b	7506-9	4	1914	"	" "	600	" "	"	0-4-4-0	8	48 in	0	—	Yes	9'-6	27'-6
11	New York Central	11-a	1100-34	35	1906	GE Co	Pass	600	3rd Rail	D. C.	4-8-4	8	44 in	8	33 in	NO	13'-0	32'-6
		11-b	1135-46	12	1906-09	"	"	600	" "	"	4-8-4	8	44 in	8	36½ in	NO	13'-0	36'-0
		11-c	1147-56	10	1913	"	"	600	" "	"	4-4-4-4	16	36 in.	0	—	Yes	5'-0	45'-7
		11-d	1157-72	16	1914-18	"	"	600	" "	"	4-4-4-4	16	36 in	0	—	Yes	5'-0	46'-5
12	New York, New Haven & Hartford	12-a	01-041	41	1907	Baldwin WE&MCo	Pass	600 DC 11000 AC	3rd Rail & Catenary	D.C & A.C 1φ	2-4-4-2	8	62 in	4	33 in	NO	8'-0	30'-10
		12 b	068	1	1916	GE Co	Frt & Switch	11000	Catenary	A.C 1φ	4-4-4-4	8	54 in	8	33 in	Yes	10'-0	54'-10
		12-c	069	1	1910	Baldwin WE&MCo	Pass Frt	600 DC 11000 AC	3rd Rail & Catenary	D.C & A.C. 1φ	2-4-4-2	8	63 in	4	36 in	NO	11'-0	39'-0
		12 d	070	1	1910	"	Frt & Switch	11000	Catenary	A.C-1φ	2-4-4-2	8	57 in	4	36 in	Yes	8'-0	43'-6
		12-e	071	1	1910	"	Pass	600 DC 11000 AC	3rd Rail & Catenary	D.C. & A.C.-1φ	2-4-4-2	8	63 in	4	42 in	Yes	7'-0	38'-6
		12-f	072	1	1911	"	"	"	"	"	2-4-4-2	8	63 in	4	36 in	Yes	7'-0	38'-6
		12 g	073-075	3	1912-13	"	"	"	"	"	2-4-4-2	8	63 in	4	36 in	Yes	8'-0	40'-6
		12-h	076-0111	36	1912-13	"	Frt.	11000	Catenary	A.C-1φ	2-4-4-2	8	63 in	4	36 in	Yes	8'-0	40'-6
		12 i	0200	1	1911	"	Switch.	11000	Catenary	A.C-1φ	0-4-4-0	8	63 in	0	—	Yes	7'-0	23'-6
		12-j	0201-14	14	1912	"	"	"	"	"	0-4-4-0	8	63 in	0	—	Yes	7'-0	23'-6
		12-k	0215	1	1912	"	"	"	"	"	0-4-4-0	8	63 in	0	—	Yes	7'-0	23'-6
		12-l	0300-4	5	1919	"	Pass	600 DC 11000 AC	3rd Rail & Catenary	D C & A.C-1φ	2-6-2-2-6-2	12	63 in	8	36 in.	Yes	14'-3	59'-6
13	New York Westchester & Boston	13	301	1	1912	Baldwin WE&MCo	Frt.	11000	Catenary	A.C-1φ	0-4-4-0	8	63 in	0	—	Yes	7'-0	23'-6
14	Norfolk & Western	14	2500-11	12	1915	Baldwin WE&MCo	Frt.	11000	Catenary	A.C-1φ A.C-Split φ	2 Cabs 2-4-4-2+2-4-4-2	16	62 in	8	30 in	Yes	11'-0	94'-10
15	Pennsylvania System	15	3931	1	1917	Penn WE&MCo	Frt.	11000	Catenary	A.C-1φ A.C Split φ	2-6-6-2	12	72 in	4	36 in	Yes	13'-4	63'-11
		15-a	32-33	2	1910	Penn WE&MCo	Pass	600	3rd Rail & Catenary	D. C.	4-4-4-4	8	68 in	8	36 in	Yes	7'-2	55'-11
		15-b	10-31 & 34-42	31	1910	"	"	600	"	"	4-4-4-4	8	72 in	8	36 in	Yes	7'-2	55'-11
		15-c	3951	1	1910	"	Switch	600	"	"	0-4-4-0	8	56 in	0	—	Yes	8'-6	26'-1
16	Paulista Railway (South America)	16-a	208-11	4	1921	GE Co	Pass	3000	Catenary	D. C.	4-4-4-4	8	42 in	8	36 in	Yes	7'-9	46'-0
		16-b	200-207	8	1921	"	Frt.	3000	"	"	0-4-4-0	8	42 in	0	—	Yes	8'-8	26'-8
		16-c	212 & 213	2	1921	WE&M Co	Pass	3000	"	"	2-4-4-2	8	63 in	4	36 in	Yes	8'-4	41'-2
		16-d	214 & 215	2	1921	"	Frt.	3000	"	"	0-6-6-0	12	40 in	—	—	Yes	14'-0	37'-0

Key No.	Weights—Lbs.: Total	Weights: On Drivers	Weights: Per Driving Axle	Weights: Mech. Parts	Weights: Elect. Parts	Dimensions: Length Over All	Dimensions: Width Over All	Dimensions: Height Top Rail to Highest Point Trolley Down	Regenerative Control	Motors: No.	Motors: Type	Motors: Method of Drive	Gear Ratio	Tractive Effort—Lbs.: One Hour Rating with Forced Ventilation	Per Cent Coef. of Adhesion	Continuous Rating with Forced Ventilation	Per Cent Coef. of Adhesion	Starting at 25% Coef. of Adhesion	Speed—M.P.H.: One Hour Rating	Continuous Rating	Max. Safe	Horse Power of Locomotive: One Hour Rating Forced Ventilation	Continuous Rating Forced Ventilation	Key No.
1a	160,000	160,000	40,000	116,000	44,000	29'-7	9'-2	13'-8	NO	4	GE 65B	Gear	19/81	(1) 36,000	22.5%	—	—	40,000	8.0	—	—	(1) 800	—	1a
1-b	185,000	185,000	46,250	119,000	66,000	39'-6	10'-2½	14'-5	No	4	GE 209A	Twin Gear	24/78	(1) 25,000	13.5%	12,800	6.9%	46,250	16.4	19.6	45	(1) 1,100	670	1-b
1c	200,000	200,000	50,000	135,000	65,000	39'-6	10'-2½	14'-5	No	4	GE 209A	Twin Gear	24/78	(1) 25,000	12.5%	12,800	6.4%	50,000	16.4	19.6	45	(1) 1,100	670	1c
2	239,000	239,000	59,750	120,600	118,400	49'-6	10'-0¾	16'-7¾	Yes	4	GE 253A	Twin Gear	18/82	(1) 42,000	17.6%	35,200	14.7%	59,750	12.2	12.7	35	(1) 1,370	1,190	2
3-a	260,000	204,000	51,000	141,800	118,200	48'-5	10'-3	14'-5	No	4	WE&MCo 403	Geared Quill	22/91	23,000	11.3%	20,500	10.0%	51,000	24.4	25.6	30	1,500	1,400	3-a
3-b	265,500	217,000	54,250	147,500	118,000	48'-0	10'-1	14'-0½	No	4	" 403A	"	22/91	23,500	10.8%	21,000	9.7%	54,200	24.2	25.3	35	1,510	1,415	3-b
4-a	160,000	160,000	40,000	100,000	60,000	37'-4	10'-0	15'-6	No	4	GE 229A	Twin Gear	18/83	(1) 30,600	19.3%	25,000	15.6%	40,000	15.4	16.2	35	(1) 1,280	1,090	4-a
4-b	160,000	160,000	40,000	100,000	60,000	37'-4	10'-0	15'-6	No	4	GE 229A	Twin Gear	25/80	(1) 20,200	12.6%	16,200	10.1%	40,000	23.4	24.6	50	(1) 1,280	1,090	4-b
5	166,000	166,000	41,500	102,540	63,460	37'-4	10'-0	15'-6	No	4	GE 229A	Twin Gear	25/80	(1) 20,200	12.2%	16,200	10.1%	41,500	23.4	24.6	50	(1) 1,280	1,090	5
6-a	143,200	143,200	35,800	80,900	62,300	41'-5	10'-1	16'-8	No	4	GE 255A	Gear	64/17	(1) 21,400	15.0%	14,000	9.8%	35,800	11.5	12.8	35	(1) 660	480	6-a
6-b	576,000	450,000	56,250	328,000	248,000	112'-0	10'-0	16'-8	Yes	8	GE 253	Twin Gear	18/82	(1) 84500	18.8%	70,700	15.7%	112,500	15.25	15.9	35	(1) 3,440	3,000	6-b
6-c	521,200	457,800	38,150	286,550	(2) 234,650	76'-0	10'-0	16'-8	Yes	12	GE 100	Direct	—	(4) 48500	10.59%	42,000	9.18%	114,450	27.1	28.4	90	(1) 3,500	3,200	6-c
6-d	556,780	367,550	61,260	297,000	(2) 270,000	88'-7	11'-0¼	17'-0	Yes	6	WE&MCo 348	Geared Quill	21/92	(8) 78,000 67,000	23.2% 20.0	58,000 48,200	17.3% 14.3	84000	20.16 23.0	22.0 25.8	55	4,200	3,400	6-d
6-e	556,780	367,550	61,260	297,000	(2) 270,000	88'-7	11'-0¼	17'-0	Yes	6	" 348	"	24/89	(8) 66,000 57,000	19.6% 16.9	49,000 40,800	14.6% 12.1	84,000	23.8 27.2	26.0 30.4	65	4200	3400	6-e
7	264,000	264000	44,000	147,300	116,700	58'-11	9'-8	15'-3	NO	6	WE&MCo 137	Geared	16/85	52,000	19.7%	37,000	14.0%	66000	10.8	13.5	30	1500	1335	7
8	230,000	230,000	57,500	121,000	109,000	44'-2	10'-0	15'-1	Yes	4	GE I 506	Twin Gear	19/81	38,000	16.5%	34,800	15.1%	57,500	15.1	15.2	30	1,500	1,400	8
9	175,800	175,800	43950	114,640	61,160	38'-8	10'-1¾	13'-6	NO	4	WE&MCo 98	Geared	22/70	23,200	13.2%	15,440	8.78%	44,800	21.2	26.7	56	1,200	1,000	9
10-a	200,000	200,000	40,000	135,000	65,000	39'-6	10'-2½	14'-8	NO	4	GE 209A	Twin Gear	19/82	(1) 35,000	17.5%	18,000	9.0%	40,000	11.8	14.0	40	(1) 1,100	670	10-a
10-b	240,000	240,000	60,000	175,000	65,000	39'-6	10'-2½	14'-8	NO	4	GE 209A	"	19/82	(1) 34000	14.2%	18,000	7.5%	60,000	12.3	14.0	40	(1) 1,100	670	10-b
11 a	227,700	140,900	35,225	167,700	60,000	38'-9	10'-1	14'-9½	NO	4	GE 84	Direct	—	(1) 21,000	14.9%	(1) 5,000	3.55%	35,225	38.5	60.0	80	(1) 2,200	(1) 800	11 a
11 b	244,500	148,500	37,125	184,500	60,000	43'-0½	10'-1	14'-6	NO	4	GE 84	"	—	(1) 21,000	14.1%	(1) 5000	3.37%	35,875	38.5	60.0	80	(1) 2,200	(1) 800	11 b
11 c	237,000	237,000	29,625	163,000	74,000	55'-2	10'-1⅛	14'-6	NO	8	GE 92	"	—	17,200	7.25%	11400	4.8%	59,250	50.5	57.5	85	2,320	1,760	11 c
11 d	265,000	265,000	33,125	177,000	88,000	56'-10	10'-1⅛	14'-6	NO	8	GE 91	"	—	20000	7.6%	14,000	5.28%	66,250	49.0	58.3	85	2,600	2,000	11 d
12-a	220,140	169,050	42,263	108,140	112,000	37'-6½	10'-2	14'-3	NO	4	WE&MCo 130	Gearless Quill	—	9,700	5.7%	6,400	3.8%	42,263	54.5	66.0	88	1,420	1,125	12-a
12-b	291,000	194,000	48,500	172,000	119,000	62'-0	10'-0	14'-5	NO	4	GE A614	Gear Side Rod	35/71	27,000	13.9%	22,200	11.5%	48,500	23.0	26.4	45	1,800	1,600	12-b
12-c	234,640	174,240	43,560	114,140	120,500	46'-8	10'-3	14'-5	NO	4 Twin	WE&MCo 409A	Geared Quill	22/92	18,300	10.5%	12,600	7.2%	43,560	36.0	41.5	54	1,700	1,350	12-c
12-d	270,000	192,000	48000	138,000	132,000	53'-8	10'-3	14'-6	NO	2	" 406	Side Rod	—	16,800	8.7%	12,000	6.2%	48,000	32.0	35.6	61	1,260	1,044	12-d
12-e	289,300	186,450	46,613	160,300	129,000	48'-0	10'-3	14'-5	NO	4	" 403	Geared Quill	34/79	13,200	7.1%	11,800	6.3%	46,613	37.0	48.0	55	1,600	1,160	12-e
12-f	256,620	190,380	47,595	128,620	128,000	48'-0	10'-3	14'-5	NO	4	" 403B	"	34/79	13,200	6.9%	11,800	6.2%	47,595	37.0	48.0	55	1,600	1,160	12-f
12-g	248,140	189,760	47,440	133,040	115,100	50'-0	10'-3	14'-6	NO	4 Twin	" 409C	"	22/92	18,200	9.6%	12,400	6.5%	47,440	36.0	41.5	54	1,700	1,350	12-g
12-h	219,500	165,000	41,250	120,900	98,600	50'-0	10'-3	14'-6	NO	4 Twin	" 409C	"	22/92	18,200	11.0%	12,400	7.5%	41,250	36.0	41.5	54	1,700	1,350	12-h
12-i	158,000	158,000	39,500	79,700	78,300	37'-0	10'-1¼	14'-2	NO	4	" 410	"	17/101	23,200	14.7%	14,800	9.4%	39,500	12.2	14.5	25	750	572	12-i
12-j	159,200	159,200	39,800	83,400	75,800	37'-6	10'-1¼	14'-2	NO	4	" 410	"	17/101	23,200	14.6%	14,800	9.3%	39,800	12.2	14.5	25	750	572	12-j
12-k	159,200	159,200	39,800	83,400	75,800	37'-6	10'-1¼	14'-2	NO	4	" 410	"	17/101	23,200	14.6%	14,800	9.3%	39,800	12.2	14.5	25	750	572	12-k
12-l	350,000	233,000	38,833	173,500	176,500	69'-0	10'-2	14'-2	NO	6 Twin	" 409C2	"	27/87	21,000	9.0%	14,500	6.2%	58,250	45.6	52.5	70	2,550	2,025	12-l
13	159,200	159,200	39,800	83,400	75,800	37'-6	10'-0	14'-2	NO	4	WE&MCo 410	Geared Quill	17/101	23,200	14.5%	14,800	9.3%	40,000	12.1	14.5	25	750	570	13
14	600,000	498,000	62,250	380,000	220,000	105'-8	10'-9	16'-0	YES	8	WE&MCo 450A	Geared Side Rod	18/85	84,000 42,000	18.5% 9.3	66,000 38,000	14.5% 8.4	114,000	14.3 28.6	14.3 28.6	35	3200	2520 2900	14
15	516,000	439,500	73,250	258,400	257,600	76'-6½	10'-1¼	15'-6	Yes	4	WE&MCo 451	Gears Jackshaft Side Rods	21/106	88,000	20.0%	73,000	16.6%	(5) 110,000	20.4	20.5	35	4800	4000	15
15-a	332,000	208,000	52,000	205,000	127,000	64'-11	10'-7¼	14'-8¾	NO	2	WE&MCo 315	Jack Shaft & Side Rods	—	(3) 21300 (4) 13600	10.2% 8.5	14,300 10,800	6.9% 5.2	(6) 52,000	30.8 45.3	35.5 54.8	80	1750 2130	1364 1580	15-a
15-b	313,000	199,000	49,750	194,000	119,000	64'-11	11'-2¼	14'-8¾	NO	2	" 315A	" "	—	(3) 20150 (4) 16600	10.1% 8.3	13,500 10,200	6.8% 5.1	(7) 49800	32.6 48.0	37.6 58.0	80	1750 (8) 2130	1354 (8) 1580	15-b
15-c	195,140	195,140	48,785	100,000	95,140	38'-9	10'-7¾	14'-6⅜	NO	2 2	" 103 " 129	Quill Gearless	—	19,820	10.1%	10,940	5.6%	(9) 38,400	11.9	14.5	40	(8) 630	(8) 423	15-c
16-a	240,000	160,000	40,000	158,900	81,100	35'-0	10'-1½	14'-3	Yes	4	GE 267A	Twin Gear	30/70	(1) 15,680	9.8%	(1) 14,720	9.2%	40,000	40.5	41.25	62.2	(1) 1680	(1) 1600	16-a
16-b	200,000	200,000	50,000	118,800	81,200	39'-2	10'-1¼	14'-3	Yes	4	" 267A	"	18/82	(1) 30600	15.3%	(1) 28800	14.4%	50,000	20.8	21.0	34.2	(1) 1680	(1) 1,600	16-b
16-c	283,800	205,800	51,450	166,800	117,000	52'-11	10'-7	14'-10		4 Twin	WE&MCo 351		28/86	(1-4) 19,400	9.4%	(4) 14,240	6.9%	51,450	43.2	47.2	65	(1) 2240	1800	16-c
16-d	234,300	234,300	39,050	145,450	88,850	50'-2	10'-6½	14'-10		6	" 350		16/63	(1-4) 29,400	12.6%	(4) 21,600	9.2%	58575	21.4	23.4	42	(1) 1680	1350	16-d

(1) Without Forced Ventilation (2) Includes Steam Heating Equipment. (3) Full Field Ratings. (4) Short Field Ratings (5) Max. T.E. 140,000
(6) Max. T.E. 69,000 (7) Max. T.E. 66,000. (8) Motors Series Parallel 300 Ratings (9) Max. T.E. of 8% adhesion limited by motor current

MULTIPLE UNIT TRAINS OF NORTH AMERICA (Heavy Service)

Company No.	Railroad	Key No.	Series No.	No. in service	Year placed in service	System of traction	Contact Conductor: Voltage	Contact Conductor: Type	Wheel diameter (inches)	Weight (lbs.): Total	Trucks without motors	On drivers	Body without equipment	Equipment
1	Boston Elevated Ry. Co.	1-a	01-0150	140	1900	D. C.	600	Third rail	M-34, T-31	68,000	20,900	43,000	34,500	12,600
		1-b	0151-74	24	1903	D. C.	600	Third rail	"	68,000	20,930	43,200	34,570	12,500
		1-c	0175-219	45	1906	D. C.	600	Third rail	"	66,628	19,500	39,000	34,620	12,500
		1-d	0220-0239	20	1911	D. C.	600	Third rail	"	65,600	19,500	40,000	34,500	12,600
		1-e	0240-0294	55	1913	D. C.	600	Third rail	"	66,600	19,500	40,000	34,500	12,600
		1-f	0295-336	40	1917	D. C.	600	Third rail	"	66,383	18,700	38,200	35,183	12,500
		1-g	0500-0539	40	1911	D. C.	600	Third rail	"	86,000	22,000	46,000	48,000	16,000
		1-h	0640-59	20	1912-13	D. C.	600	Third rail	"	86,400	21,950	45,300	48,050	16,200
		1-i	0660-0694	35	1918	D. C.	600	Third rail	"	86,000	22,500	46,000	48,500	15,000
2	Brooklyn Rapid Transit Co.	2-a	....	550	1902 & later.	D. C.	600	Third rail	....	....	....	....	....	......
		2-b	....	100	1902 & later.	D. C.	600	Third rail	....	....	....	....	....	......
		2-c	2000-2899	900	1914 to 1921.	D. C.	600	Third rail	34	90,600	22,560	57,300	52,640	15,800
3	Canadian Nat'l Rys. (Mt. Royal)	3	....	8	1921	D. C.	2,400	Catenary	36	120,000	30,000	120,000	51,000	39,000
4	Chicago Elevated Ry. Co.	4-a	....	26	1904	D. C.	600	Third rail	34	69,500	22,000	41,000	31,000	13,500
		4-b	....	150	1905	D. C.	600	Third rail	34	59,500	19,900	35,600	26,000	13,600
		4-c	....	105	......	D. C.	600	Third rail	34	....	....	....	....	......
		4-d	....	40	1914	D. C.	600	Third rail	34	68,500	20,900	41,000	37,500	11,100
		4-e	....	19	1914	D. C.	600	Third rail	34	70,000	19,900	42,000	35,500	14,600
5	Chicago, North Shore & Milwaukee R. R.	5-a	....	6	1904	D. C.	600	Dir. Susp.	36	67,000	18,000	67,000	32,000	17,000
		5-b	....	34	1906-10	D. C.	600	Dir. Susp.	36	76,000	18,000	76,000	40,000	18,000
		5-c	....	45	1915-21	D. C.	600	Dir. Susp.	36	93,000 100,000	32,000	93,000 100,000	42,000 49,000	19,000
		5-d	....	45	1915-21	D. C.	600	Dir. Susp.	36	93,000 100,000	32,000	93,000 100,000	42,000 49,000	19,000
6	Erie R. R. Co.	6-a	....	8	1907-12	A. C.	11,000	Catenary	36	98,000	....	98,000	....	38,000
		6-b	....	....	....	....	....	....	....	117,000	25,000	117,000	49,000	13,000
7	Hudson & Manhattan R. R.	7-a	Class A	50	1907	D. C.	600	Third rail	M-34½, T-30	74,550	23,750	47,000	35,170	15,630
		7-b	Class B	90	1909	D. C.	600	Third rail	"	69,620	21,890	43,800	32,100	15,630
		7-c	Class C	50	1910	D. C.	600	Third rail	"	69,620	21,890	43,500	32,100	15,630
		7-d	Class D	96	1911	D. C.	600	Third rail	M-36, T-33	73,000	23,900	46,000	33,100	16,000
		7-e	Class E	25	1921	D. C.	600	Third rail	M-34½, T-30	73,500	24,346	46,200	37,054	12,100
8	Interborough Rapid Transit Co.	8-b	....	272	1904	D. C.	600	Third rail	M-34½, T-31½	85,500	23,900	51,000	47,000	14,600
		8-j	....	88	1910	D. C.	600	Third rail	"	59,200	17,700	36,000	26,900	14,600
		8-k	....	60	1910	D. C.	600	Third rail	"	59,200	17,700	36,000	26,900	14,600
		8-l	....	6	1915	D. C.	600	Third rail	"	73,000	23,000	46,000	39,800	10,200
		8-m	....	320	1915	D. C.	600	Third rail	"	73,800	19,200	39,800	43,100	11,500
		8-v	....	169	1917	D. C.	600	Third rail	"	75,500	23,000	45,000	39,000	13,500
		8-a	....	828	1902-3	D. C.	600	Third rail	"	55,120	20,010	33,530	24,030	11,000
		8-c	....	200	1904	D. C.	600	Third rail	"	58,500	16,300	35,040	27,700	14,500
		8-d	....	272	1904	D. C.	600	Third rail	"	85,460	23,920	51,000	47,040	14,500
		8-e	....	91	1907	D. C.	600	Third rail	"	59,160	23,920	35,700	21,750	13,500
		8-f	....	40	1907	D. C.	600	Third rail	"	83,200	25,100	49,869	44,600	13,500
		8-g	....	190	1909	D. C.	600	Third rail	"	83,200	25,100	49,869	44,600	13,500
		8-h	....	88	1910	D. C.	600	Third rail	"	59,160	17,700	36,000	26,960	14,500
		8-i	....	60	1910	D. C.	600	Third rail	"	59,160	17,700	36,000	26,960	14,500
		8-n	....	6	1915	D. C.	600	Third rail	"	70,960	27,680	45,000	33,100	10,180
		8-o	....	6	1915	D. C.	600	Third rail	"	73,000	23,000	40,000	39,820	10,180
		8-p	....	161	1915	D. C.	600	Third rail	"	75,000	27,000	45,000	37,500	10,500
		8-q	....	320	1915	D. C.	600	Third rail	"	73,788	19,200	39,780	43,082	11,500
		8-r	....	103	1915	D. C.	600	Third rail	"	75,500	27,000	45,000	35,000	13,500
		8-s	....	71	1915	D. C.	600	Third rail	"	71,000	33,000	40,740	27,500	10,500
		8-t	....	108	1917	D. C.	600	Third rail	"	75,500	33,000	45,250	29,000	13,500
		8-u	....	169	1917	D. C.	600	Third rail	"	75,500	33,000	45,250	29,000	13,500
9	Long Island R. R. Co.	9-a	....	135	....	....	....	....	....	....	....	....	....	......
		9-b	....	300	....	....	....	....	....	....	....	....	....	......
10	Metropolitan West Side Elevated Ry. (Chicago & Oak Park.)	10-a	....	14	1904	D. C.	600	Third rail	34	65,000	16,000	38,600	37,000	12,000
		10-b	....	77	1907	D. C.	600	Third rail	34	55,000 to 70,000	22,000	38,500 to 41,000	26,600 to 31,600	16,400
		10-c	....	26	1904	D. C.	600	Third rail	34	69,500	22,000	41,000	31,000	.....
		10-d	....	61	1914-15	D. C.	600	Third rail	34	70,000	19,900	42,000	35,440	14,600
11	New York Central R. R.	11-a	4100-123	124	1907	D. C.	600	Third rail	M-36, T-33	107,500	25,150	61,350	63,650	18,700
		11-b	4124	1	1907	D. C.	600	Third rail	"	112,100	25,150	63,650	68,250	18,700
		11-c	4155-72	18	1907	D. C.	600	Third rail	"	119,000	26,300	65,200	74,000	18,700
		11-d	4173	1	1907	D. C.	600	Third rail	"	112,300	26,300	61,850	67,300	18,700
		11-e	4125-54	30	1907	D. C.	600	Third rail	"	114,000	26,300	61,300	69,000	18,700
		11-i	4174-92	19	1913	D. C.	600	Third rail	"	117,500	26,350	65,700	72,450	18,700
		11-f	4350-55	6	1907-10	D. C.	600	Third rail	"	113,500	25,150	63,900	69,650	18,700
		11-j	4356-61	6	1913	D. C.	600	Third rail	"	116,000	26,300	65,800	71,000	18,700
		11-k	4193-204	12	1917	D. C.	600	Third rail	"	132,200	33,650	73,100	82,850	15,700
		11-l	4205-37	33	1918-21	D. C.	600	Third rail	"	129,000	33,800	71,600	79,500	15,700
		11-g	4394-97	4	1910	D. C.	600	Third rail	"	119,400	25,150	67,200	75,550	18,700
		11-h	4398-99	2	1910-18	D. C.	600	Third rail	"	118,700	26,000	65,150	74,000	18,700
12	New York, New Haven & Hartford	12-d	4010	1	1914	*A. C.	11,000	Catenary	36	156,500	37,700	156,500	86,687	14,000
		12-b	4011	1	1911	*A. C.	11,000	Catenary	36	139,700	23,013	13,970	60,087	56,600
		12-a	4020-23	4	1909	D. C.-A. C.	600-11,000	Third rail and Cat.	42	173,500	41,000	173,500	65,700	56,800
		12-c	4024-27	4	1912	"	"	"	42	171,100	40,500	171,100	69,000	51,600
		12-e	4028-40	13	1914	"	"	"	42	176,000	40,500	176,000	69,000	56,500
		12-f	4060-61	2	1915	*A. C.	11,000	Catenary	42	169,000	40,500	169,000	68,500	50,000
		12-g	4062-63	2	1916	*A. C.	11,000	"	42	170,000	40,440	170,000	68,500	54,160
		12-h	....	6	1921	A. C.-D. C.	600-11,000	Third rail & Cat'ry.	42	176,000	49,500	176,000	69,000	56,500
		12-i	....	2	1921	"	"	"	42	176,000	40,500	176,000	69,000	56,500
13	New York, Westchester & Boston	13	101-140	40	1911 & 1917	A. C.	11,000	Catenary	M-42, T-36	120,000	29,200	71,570	....	......
14	New York Municipal Ry.	14	....	900	1914-20	D. C.	600	Third rail	M-34, T-31	90,600	22,560	57,300	(52,640	15,800
15	Northwestern Elevated R. R.	15-a	....	192	1900-06	D. C.	600	Third rail	34	65,000 to 60,000	18,300 to 20,950	39,000 to 41,000	30,200 to 31,550	16,500
		15-b	....	20	1908	D. C.	600	Third rail	34	69,000	20,950	41,000	31,550	16,500
		15-c	....	20	1914	D. C.	600	Third rail	34	68,500	20,950	41,000	37,500	......
		15-d	....	43	1914-15	D. C.	600	Third rail	34	70,000	19,960	42,000	35,440	14,600
		15-e	....	19	1914-15	D. C.	600	Third rail	34	70,000	19,960	42,000	35,440	......
16	Pennsylvania R. R. (New York)	16-a	201-206	6	1910	D. C.	600	Third rail	38	110,350	26,000	63,550	60,000	24,350
	Pennsylvania R. R. (Philadelphia)	16-b	4513-14	2	1910	D. C.	600	Third rail	38	108,350	26,000	62,300	58,000	22,350
		16-c	501-82	82	1915	A. C.	11,000	Catenary	....	118,600	31,800	70,600	60,000	26,800
		16-d	4548-51, 4553-57	9	1915	A. C.	11,000	Catenary	....	116,600	31,800	70,600	58,000	26,800
		16-e	5296-97	2	1915	A. C.	11,000	Catenary	....	121,600	31,800	70,100	63,000	26,800
		16-f	584-603	20	1917	A. C.	11,000	Catenary	....	118,600	31,800	70,600	60,000	26,800
		16-g	5909-70	2	1917	A. C.	11,000	Catenary	....	113,600	31,800	68,100	55,000	26,800
17	Philadelphia Rapid Transit Co.	17-a	....	40	1906	D. C.	600	Third rail	34	71,000	23,000	46,200	34,150	13,850
		17-b	....	40	1907	D. C.	600	Third rail	34	76,000	28,500	49,400	33,650	13,850
		17-c	....	16	1909	D. C.	600	Third rail	34	72,000	23,000	46,800	35,150	13,850
		17-d	....	4	1909	D. C.	600	Third rail	34	76,000	28,500	49,400	33,650	13,850
		17-e	....	65	1911	D. C.	600	Third rail	34	70,500	23,000	45,800	33,650	13,850
		17-f	....	50	1913	D. C.	600	Third rail	34	70,000	23,000	45,500	34,300	12,100
		17-g	....	50	1921	D. C.	600	Third rail	33	72,500	....	....	....	......
18	Southern Pacific Co. (O. A. & B. Div.)	18	....	81	1911	D. C.	1,200	Catenary	36	109,400	24,280	109,400	61,520	23,600
19	South Side Elevated R. R.	18-a	....	149	1897	D. C.	600	Third rail	34	114,000		114,000	66,120	
		19-b	....	70	1900-3	D. C.	600	Third rail	34	52,714	15,300	31,500	27,000	10,400
		19-c	....	150	1905	D. C.	600	Third rail	34	55,000	17,500	32,900	24,600	12,900
		19-d	....	61	1914-15	D. C.	600	Third rail	34	59,500	19,900	35,600	....	......
20	West Jersey & Sea Shore R. R.	20-a	6701-62	60	1906	D. C.	675	Third rail, Dir. Susp.	M-36, T-33	70,000	19,960	42,000	35,440	14,600
										80,000	25,045	52,800	46,405	16,550
		20-d	6763-79	17	1907	D. C.	675	"	"	94,700	25,900	56,200	52,250	16,550
		20-e	5135-36	2	1907	D. C.	675	"		94,000	25,900	55,900	51,550	16,550
		20-g	6780-92	13	1912	D. C.	675	"	36	106,000	29,100	61,400	60,000	16,900
		20-h	5137-38	2	1912	D. C.	675	"	36	104,000	29,100	61,400	58,000	16,900
		20-b	5455-7-8	3	1906	D. C.	675	"	M-36, T-33	88,000	25,045	52,800	46,405	16,550
		20-c	6421-26, 6439-41	9	1906-9	D. C.	675	"	"	92,000	25,900	54,875	49,550	16,550
		20-f	6427	1	1911	D. C.	675	"	36	101,000	29,100	71,000	55,000	16,900

* Single P. H.

MULTIPLE UNIT TRAINS OF NORTH AMERICA (Heavy Service)

Company No.	Railroad	Dimensions: Length over all	Width over all	Height top rail to highest point trolley down	Wheel base: Rigid	Total	Motors: No.	Type	Gear ratio	One hour rating forced ventilation: Total T. E. (lbs.)	Speed M. P. H.	H. P. each motor	Seating capacity	Key No.
1	Boston Elevated Ry. Co.	46'-7¼"	8'-9½"	12'-6¼"	6'-0"	38'-3½"	2	W-301	18:59	6,000	22	175	48	1-a
		46'-7¼"	8'-9½"	12'-6¼"	6'-0"	38'-3½"	2	GE-259 B	60:17	4,775	18	120	48	1-b
		46'-7¼"	8'-9½"	12'-6½"	M-6'-1" T-6'-0"	38'-4"	2	GE-259 B	60:17	4,775	18	120	48	1-c
		46'-7¼"	8'-9½"	12'-6½"	6'-0"	38'-3½"	2	W-301	18:59	6,000	22	175	48	1-d
		46'-7¼"	8'-9½"	12'-6½"	6'-0"	38'-3½"	2	W-301	18:59	6,000	22	175	4[illegible]	1-e
		46'-7¼"	8'-9½"	12'-6½"	M-6'-1" T-6'-0"	38'-3½"	2	GE-259	60:17	4,775	18	120	48	1-f
		69'-6½"	9'-6"	12'-8½"	M-7'-0" T-6'-0"	57'-6"	2	W-300	20:63	8,000	21	220	72	1-g
		69'-6½"	9'-6"	12'-8½"		57'-6"	2	GE-212	63:20	8,600	18	225	72	1-h
		69'-6½"	9'-6"	12'-8½"		57'-6"	2	W-577	20:63	6,900	21.5	200	72	1-i
2	Brooklyn Rapid Tranist Co.	...	...	...	...	...	2	W-50	...	...	...	180	...	2-a
		...	...	...	...	...	2	W-300	...	...	...	220	...	2-b
		67'-0"	10'-0"	12'-2"	6'-8"	50'-4"	2	GE-248	...	...	...	...	...	2-c
3	Canadian Nat'l Rys. (Mt. Royal)	67'-6"	10'-3"	15'-0"	7'-0"	53'-0"	4	GE-239	66:2[illegible]	9,600	23	150	68	3
4	Chicago Elevated Ry. Co.	47'-9½"	8'-9"	12'-10"	6'-6"	43'-0"	2	W-109	...	...	...	180	48	4-a
		47'-3"	8'-8"	12'-8"	6'-1"	40'-1"	2	W-121	17:58	...	...	100	52	4-b
		...	...	...	...	...	2	W-114	...	...	...	175	...	4-c
		46'-7¼"	8'-8"	13'-5"	6'-0"	38'-8"	2	W-302	...	...	...	140	48	4-d
		48'-6¾"	8'-8"	12'-3½"	6'-8"	40'-0"	2	W-567	17:60	6,400	20	172	52	4-e
5	Chicago, North Shore & Milwaukee R. R.	46'-9"	9'-1½"	13'-7½"	6'-0"	31'-10"	4	GE-74	67:22	4,918	20.6	65	46	5-a
		52'-3"	8'-8"	13'-10 3/16"	6'-0"	35'-10"	4	GE-73	52:22	5,200	22	75	5[illegible]	5-b
		56'-1"	8'-8"	12'-10½"	7'-0"	39'-8"	4	W-577	54:22	5,120	41	140	56	5-c
		56'-1"	8'-8"	12'-10½"	7'-0"	39'-8"	4	W-557	23:5[illegible]	7,800	27	140	56	5-d
6	Erie R. R. Co.	53'-3"	8'-6"	15'-6"	6'-8"	36'-0"	4	W-132	20:63	...	...	...	...	6-a
		67'-3"	9'-8"	16'-1½"	7'-0"	49'-0"	4	W-132-C	20:63	...	...	...	...	6-b
7	Hudson & Manhattan R. R.	48'-3"	8'-11 3/16"	12-0"	M-6'-6" T-5'-6"	39'-5½"	2	GE-76	62:19	7,200	16	150	4[illegible]	7-a
		48'-5"	8'-11½"	11'-8 7/16"	"	39'-5½"	2	GE-76	62:19	7,200	16	150	44	7-b
		48'-5"	8'-11½"	11'-8 7/16"	"	39'-5½"	2	GE-76	62:19	7,200	16	150	44	7-c
		48-3½"	8'-8½"	11'-8½"	7'-0"	40'-0"	2	GE-212-C	53:22	6,740	27	225	44	7-d
		51'-3½"	8'-11½"	11'-9 7/16"	M-6'-6", T-5'-6"	39'-5½"	2	GE-259	60:17	4,775	18	120	44	7-e
8	Interborough Rapid Transit Co.	51'-0½"	9'-0½"	12'-0"	M-6'-8", T-5'-6"	42'-3"	2	W-86	19:63	7,500	19.5	200	...	8-b
		47'-0½"	8'-9½"	13'-4"	M-6'-0", T-5'-0"	38'-8"	2	W-300	20:63	8,000	21	220	48	8-j
		47'-0½"	8'-9½"	13'-4"	"	38'-8"	2	W-302	16:61	5,800	18	140	48	8-k
		51'-0½"	9'-0½"	12'-0"	M-6'-8", T-5'-6"	42'-3"	2	W-302	17:60	5,400	19.5	140	48	8-l
		51'-0½"	9'-0½"	12'-0"	"	42'-3"	2	W-333	16:61	4,200	21	115	48	8-m
		51'-0½"	9'-0½"	12'-0"	"	42'-3"	2	W-577	21:62	6,500	23	200	48	8-v
		47'-0½"	8'-9½"	13'-3¼"	M-6'-0", T-5'-0"	38'-8"	2	GE-66A	61:16	6,600	14.5	125	...	8-a
		47'-0½"	8'-9½"	13'-3¼"	"	38'-8"	2	GE-69-B	63:20	8,100	18.4	200	...	8-c
		51'-0½"	9'-0½"	12'-0"	M-6'-8", T-5'-6"	42'-3"	2	W-86-B	63:19	...	...	...	...	8-d
		47'-0½"	8'-9½"	13'-3¼"	M-6'-0", T-5'-0"	38'-8"	2	GE-211-A	61:16	5,460	18.9	160	48	8-e
		47'-0½"	8'-9½"	13'-3¼"	"	38'-8"	2	GE-212-A	63:20	8,760	20.4	235	48	8-f
		51'-0½"	9'-0½"	12'-0"	M-6'-8", T-5'-6"	42'-3"	2	GE-212-A	63:20	8,760	20.4	235	...	8-g
		47'-0½"	8'-9½"	13'-3¼"	M-6'-0", T-5'-0"	38'-8"	2	W-300	64:20	...	...	...	48	8-h
		47'-0½"	8'-0½"	13'-3¼"	"	38'-8"	2	W-302	61:16	...	...	...	...	8-i
		51'-0½"	9'-0½"	12'-0"	M-6'-8", T-5'-6"	42'-3"	2	GE-240-C	60:16	3,120	22.7	94	48	8-n
		51'-0½"	9'-0½"	12'-0"	"	42'-3"	2	W-302-F	60:17	...	...	...	48	8-o
		51'-0½"	9'-0½"	12'-0"	"	42'-3"	2	GE-259-A	61:16	4,040	22.6	120	...	8-p
		51'-0½"	9'-0½"	12'-0"	"	42'-3"	2	W-333	61:16	...	...	...	...	8-q
		51'-0½"	9'-0½"	12'-0"	"	42'-3"	2	GE-260-A	62:21	6,250	23	195	48	8-r
		51'-0½"	9'-0½"	12'-0"	"	42'-3"	2	GE-259-A	61:16	4,040	22.6	120	...	8-s
		51'-0½"	9'-0½"	12'-0"	"	42'-3"	2	GE-260-A	62:21	6,250	23	195	48	8-t
		51'-0½"	9'-0½"	12'-0"	"	42'-3"	2	W-577	62:21	...	...	...	...	8-u
9	Long Island R. R. Co.	...	...	...	...	...	...	W-113	...	...	...	210	...	9-a
		...	...	...	...	...	...	W-308	...	...	...	210	...	9-b
10	Metropolitan West Side Elevated Ry (Chicago and Oak Park).	47'-9½"	8'-9"	12'-10"	5'-0"	38'-7"	2	GE-2,000	3:17	4,000	21	135	40	10-a
		47'-9½"	8'-9"	12'-10"	6'-0"	39'-7"	2	GE-55	55:18	7,600	16	160	48	10-b
		47'-9½"	8'-9"	12'-10"	6'-6"	21'-1"	2	W-109	3:17	...	...	...	48	10-c
		48'-6¾"	8'-8"	12'-3½"	6'-8"	40'-0"	2	GE-243	60:17	6,400	19	155	52	10-d
11	New York Central R. R.	62'-2"	9'-9"	14'-10"	7'-0"	45'-0"	2	GE-69-C	49:26	5,700	27	195	70	11-a
		62'-2"	9'-9"	14'-10"	7'-0"	45'-0"	2	GE-69-C	49:26	5,700	27	195	70	11-b
		62'-2"	9'-9"	14'-10"	7'-0"	45'-0"	2	GE-69-C	49:26	5,700	27	195	70	11-c
		62'-2"	9'-9"	14'-10"	7'-0"	45'-0"	2	GE-69-C	49:26	5,700	27	195	70	11-d
		62'-2"	9'-9"	14'-10"	7'-0"	45'-0"	2	GE-69-C	49:26	5,700	27	195	70	11-e
		63'-7"	9'-9"	14'-10"	7'-0"	46'-5"	2	GE-69-C	49:26	5,700	27	195	74	11-i
		62'-2"	9'-9"	14'-10"	7'-0"	45'-0"	2	GE-69-C	49:26	5,700	27	195	42	11-f
		63'-7"	9'-9"	14'-10"	7'-0"	46'-6"	2	GE-69-C	49:26	5,700	27	195	46	11-j
		69'-5"	9'-9"	14'-10"	8'-0"	52'-10"	2	GE-260-B	51:18	6,000	24	195	82	11-k
		69'-5"	9'-9"	14'-10"	8'-0"	52'-10"	2	GE-260-B	51:18	6,000	24	195	82	11-l
		61'-2"	9'-9"	14'-10"	7'-0"	45'-0"	2	GE-69-C	49:26	5,700	27	195	0	11-g
		61'-2"	9'-9"	14'-10"	7'-0"	45'-0"	2	GE-69-C	49:26	5,700	27	195	0	11-h
12	New York, New Haven & Hartford.	71'-11"	9'-8¾"	14'-3"	8'-0"	55'-7¾"	4	GE-A 613B	67:23	8,800	23	150	76	12-d
		70'-5"	9'-7¾"	14'-3"	8'-0"	55'-7¾"	4	GE-A 613B	67:23	8,800	23	150	76	12-b
		70'-10½"	9'-7¾"	14'-3"	8'-0"	55'-7¾"	4	W-156	23:76	...	...	...	76	12-a
		70'-10½"	9'-7¾"	14'-3"	8'-0"	55'-7¾"	4	W-409-D	27:73	...	...	...	76	12-c
		71'-11"	9'-8¾"	14'-3"	8'-0"	55'-7¾"	4	W-409-D	27:73	...	...	...	76	12-e
		71'-11"	9'-8¾"	14'-3"	8'-0"	55'-7¾"	4	W-412	22:58	...	...	...	76	12-f
		71'-11"	9'-8¾"	14'-5"	8'-0"	55'-7¾"	4	GEA 613D	77:23	10,120	20	150	76	12-g
		71'-11"	9'-8¾"	14'-3"	8'-0"	55'-7¾"	4	W-409-D	27:73	...	...	...	76	12-h
		71'-11"	9'-8¾"	14'-3"	8'-0"	55'-7¾"	4	W-317	19:61	...	...	...	76	12-i
13	New York, Westchester & Boston	72'-0¾"	9'-10"	14'-9¾"	8'-0"	55'-7¾"	4	W-409-B	25:68	...	...	...	78	13
14	New York Municipal Ry.	67'-0"	10'-0"	12'-2"	6'-8"	50'-4	2	GE-248	61:22	5,300	22.5	160	90	14
15	Northwestern Elevated R. R.	46'-7¾"	8'-8"	13'-5"	6'-0"	38'-8"	2	GE-55	56:17	7,600	16	160	48	15-a
		46'-7¾"	8'-8"	13'-2"	6'-0"	38'-8"	2	GE-211-B	58:17	7,600	16	160	48	15-b
		46'-7¾"	8'-8"	13'-5"	6'-0"	38'-8"	2	W-302	3:41	...	...	...	48	15-c
		48'-6¾"	8'-8"	12'-3½"	6'-8"	40'-0"	2	GE-243	60:17	6,400	19	155	52	15-d
		48'-6¾"	8'-8"	12'-3½"	6'-8"	40'-0"	2	W-567	60:17	...	...	...	52	15-e
16	Pennsylvania R. R. (New York)	64'-0¾"	9'-11½"	13'-3½"	7'-0"	46'-9"	2	W-308	25:48	*5,100	*33	*225	72	16-a
		64'-0¾"	9'-11½"	13'-3½"	7'-0"	46'-9"	2	W-308	25:48	*5,100	*33	*225	52	16-b
	Pennsylvania R. R. (Philadelphia)	64'-0½"	9'-11½"	15'-0¾"	M8'-8" T8'-0"	48'-1"	2	W-412-A	24:55	3,800	44.5	225	72	16-c
		64'-0½"	9'-11½"	15'-0¾"	M8'-8" T8'-0"	48'-1"	2	W-412-A	24:55	3,800	44.5	225	52	16-d
		64'-0½"	9'-11½"	15'-0¾"	M8'-8" T8'-0"	48'-1"	2	W-412-A	24:55	3,800	44.5	225	—	16-e
		64'-0½"	9'-11½"	15'-0¾"	M8'-8" T8'-0"	48'-1"	2	W-412-A	24:55	3,800	44.5	225	72	16-f
		64'-0½"	9'-11½"	15'-0¾"	M8'-8" T8'-0"	48'-1"	2	W-412-A	24:55	3,800	44.5	225	—	16-g
17	Philadelphia Rapid Transit Co.	49'-7"	8'-8"	12'-6"	6'-7"	40'-2"	2	GE-66	61:17	5,200	18	125	48	17-a
		49'-7"	8'-8"	12'-6"	6'-9"	40'-2"	2	GE-66	61:17	5,200	18	125	48	17-b
		49'-7"	8'-8"	12'-6"	6'-8"	40'-2"	2	GE-66	61:17	5,200	18	125	48	17-c
		49'-7"	8'-8"	12'-6"	6'-9"	40'-2"	2	GE-66	61:17	5,200	18	125	48	17-d
		49'-7"	8'-8"	12'-6"	6'-8"	40'-2"	2	GE-66	61:17	5,200	18	125	48	17-e
		49'-7"	8'-8"	12'-6"	6'-8"	40'-2"	2	GE-222	61:17	5,900	18	140	48	17-f
		...	...	...	...	...	...	GE-259	16:61	...	...	...	...	17-g
18	Southern Pacific Co. (O. A. & B. Division)	72'-10½"	10'-4"	15'-7"	7'-0"	52'-0"	4	GE-207	64:17	11,680	18	140	116	18
19	South Side Elevated R. R.	47'-1"	8'-8"	12'-8"	5'-6"	38'-2"	2	GE-57-B	2:95	2,450	16	50	46	19-a
		47'-3"	8'-8"	12'-8"	5'-6"	38'-5"	2	GE-73-A	21:68	2,500	16	75	44	19-b
		47'-3"	8'-8"	12'-8"	6'-1"	40'-1"	2	W-121	3:41	...	...	...	52	19-c
		48'-0¾"	8'-8"	12'-3½"	6'-8"	40'-0"	2	GE-243	60:17	6,400	19	155	52	19-d
20	West Jersey & Sea Shore R. R.	55'-2¼"	10'-0½"	15'-3 5/16"	7'-0"	40'-0"	2	GE-69-C	46:29	4,600	32.4	200	58	20-a
		55'-2¼"	10'-0¼"	15'-3 5/16"	M-7'-3", T-7'-0"	40'-1¼"	2	GE-69-C	46:29	4,600	32.4	·200	58	20-d
		55'-2¼"	10'-0¾"	15'-3 5/16"	"	40'-1¼"	2	GE-69-C	46:29	4,600	32.4	200	58	20-e
		64'-0¾"	9'-11½"	15'-1"	8'-0"	47'-9"	2	GE-212-F	52:23	6,000	29.3	235	72	20-g
		64'-0¾"	9'-11½"	15'-1"	8'-0"	47'-9"	2	GE-212-F	52:23	6,000	29.3	235	72	20-h
		55'-2¼"	10'-0¼"	15'-3 5/16"	7'-0"	40'-0"	2	GE-69-C	46:29	4,600	32.4	200	0	20-b
		55'-2¼"	10'-0¼"	15'-3 5/16"	M-7'-3", T-7'-0"	40'-1¼"	2	GE-69-C.	46:29	4,600	32.4	·200	0	20-c
		64'-0¾"	9'-11¼"	13'-1"	8'-0"	47'-9"	2	GE-212-F	52:23	6,000	29.3	235	0	20-f

* Natural Ventilation.

Report of Committee on Train Lighting Equipment and Practice

Investigation of the Question of Direct Drives Develops the Fact That Many Have Been Tried But Their Value Remains to Be Proved

Committee:—

L. S. Billau, Chairman, Assistant Electrical Engineer, Baltimore & Ohio; E. Wanamaker, Electrical Engineer, Chicago, Rock Island & Pacific; E. W. Jansen, Electrical Engineer, Illinois Central; F. J. Hill, Chief Electrician, Car Department, Michigan Central; C. H. Quinn, Chief Electrical Engineer, Norfolk & Western; J. R. Sloan, Chief Electrician, Central Region, Pennsylvania System.

To the Members:

Your Committee was directed by the Executive Committee (1) to make an investigation to determine the merits of direct driving axle generators for passenger cars, and (2) to give consideration to revision of the section covering lamp regulators of the standard specification for axle generators which was not considered entirely satisfactory. Your Committee submits the following report on these two subjects:

With respect to the direct drive for axle generators, this has been interpreted to cover any mechanical form of drive other than by belt.

So far as your Committe is aware, the solution of the problem has been attempted by the following, approximately in the order given, although our information on this point is not definite.

1. W. L. Bliss.
2. E. I. Deutsch.
3. E. M. Fitz.
4. The Gould Coupler Co.—Chain Drive.
5. The Safety Car Heating & Lighting Co.
6. The Gould Coupler Co.—Shaft Drive.
7. W. A. Pitt.
8. A. H. Matthews.
9. United States Light and Heat Corporation.
10. Canadian Pacific Railway.
11. George G. Milne.
12. D. C. Wilson.

The "Bliss" Drive

The drive as finally evolved, and commonly known as the "hollow shaft drive," consists essentially of the following:

1. A split two armed dog securely clamped to the axle.

2. A split hollow shaft surrounding the axle, journaled in roller bearings, whose outer race was machined in an extension of the generator frame, and carrying two diametrically opposite arms at one end.

3. Four open-wound helical springs, these springs being fitted with a casting at one end, this casting ending in a ball, and these balls fitting in spherical sockets located in the arms of the dog and in the arms of the hollow shaft.

4. A gear mounted on the hollow shaft meshing with—

5. A pinion mounted on the armature shaft.

The springs when applied were neither extended nor compressed, so that, for one direction of rotation, one pair were in compression and the other pair in tension. Reversing the direction of rotation placed the first pair in tension and the second pair in compression.

This drive and the system of axle generator regulation with which it was used were described by Mr. Bliss in a paper read before the American Institute of Electrical Engineers, February 27, 1903.

The "hollow shaft drive" was first applied during 1898 to Pullman Car "Pennsylvania," operating between Jersey City and Washington over the Pennsylvania Railroad.

Previous to the use of the helical springs, which were applied in about 1902, various means of transmitting the motion from the axle to the hollow shaft had been tried out and discarded for various reasons as being unsatisfactory.

Considered solely as a means of transmitting power from the car axle, the drive as shown was successful and the equipment as a whole operated satisfactorily for some time.

The equipment was removed in 1904 on account of the wear that had occurred in the outer race.

As one-half of this race was machined in the same castings as one-half of the field frame renewing the one meant renewing the other, and the expense involved was greater than was thought justifiable.

It should be noted that with this type of drive that no matter what the movement of the axle may be, only pure rotation is transmitted to the hollow shaft, and that a special axle is not required.

The "Deutsch" Drive

The "Deutsch" Drive consists of a split bevel gear, mounted on the axle, meshing with a bevel pinion mounted on a shaft and carried in a split gear box surrounding both gear and pinion. The gear box was prevented from turning by a vertical member that was attached in some manner to the truck frame as shown in the cut. The axle was turned for a bearing for the gear box, one bearing seat only being provided.

The gear was clamped to the axle by means of four bolts, all bearings in the gear box were plain sleeve bearings.

The shaft carrying the pinion had, on its outboard end, one portion of a universal joint. The other portion was carried on an extension shaft provided with a feather key, while on the other end of this shaft was a portion of a second universal joint which connected to the balance of same mounted on the end of the armature shaft.

This drive was in service on Canadian Pacific Sleeper "Narbome" and on about ten cars of the Grand Trunk and Intercolonial Railways and one car on the Lake Shore & Michigan Southern.

The drive did not give satisfaction, the trouble being ascribed by Mr. Deutsch to the fundamental mistake of providing only one bearing for the gear case and pinion support instead of two, and to the poor lubrication obtained, especially during cold weather. The result was that the gear and pinion tended to become unmeshed, ending finally in the destruction of the pinion.

These drives were in service in 1906 or 1907 and the best results were obtained on the L. S. & M. S. where

7,000 miles were obtained before the transmission required new bearing bushings and pinions.

The "Fitz" Drive

In the "Fitz" Drive the armature is built on a hollow spider having a bore sufficient to easily slip over the largest diameter of axle, this bore being enlarged in places for a short distance at each end, thus providing radial pockets in which helical springs under compression are placed, one end of the spring bearing on the circumference of the enlarged bore, the other through a steel shoe on the circumference of the axle.

Ears are also provided on the armature spider, which project through the opening between the two halves of a driving dog clamped on the axle. Motion is, therefore, transmitted from the axle to the armature through the joint action of the driving dog and the helical sprinngs.

The driving dog also serves to retain the helical springs in the pockets.

It should be noted that with this construction, the armature being practically rigidly connected to the axle, the armature and field frame must move with the axle, partaking of all its motions.

The record of the one equipment constructed having this drive was as follows:

On test rack, friction bearing with various oils and greases	126,000 M.
On test rack, ball bearings	120,000 M.
On PH coach 8243—Columbus-Cincinnati	20,000 M.
On mail car 8608—Columbus-Chicago	11,350 M.
On mail car 7262—New York-St. Louis	10,990 M.
On Pullman car "Quantico"—Columbus-St. Louis	12,670 M.
On PH coach 8236—Columbus-Cincinnati	7,200 M.
Total	308,210 M.

All the information we were able to obtain tended to show that the drive operated satisfactorily to transmit the power.

The "Gould Chain" Drive

The "Gould Coupler Company's Chain" Drive consisted of a split hub which was centered on the car axle by means of set screws, the space between the axle and interior of the hub being filled with babbitt, and clamped by bolts to the axle. A split sprocket shrouded on the outside was then mounted on and keyed to this hub.

The armature sprocket was somewhat similar in construction except that it was not split. Connection was made between the two sprockets by a Morse Silent Chain. This drive was in service on several roads and uniformly gave excellent service.

It was found, however, that it was impossible to operate it satisfactorily, using a new chain with old sprockets, or vice versa, so that when one part wore out it was necessary to renew all parts.

The armature sprocket would require renewals after about 100,000 miles service, and the expense of operation did not make it an economical proposition as compared with a belt, and therefore the drive was abandoned.

The "Safety" Drive

The first drive of the Safety Car Heating & Lighting Company consisted of a bevel gear secured to the car axle, meshing with a bevel pinion, both being enclosed in a housing mounted on the axle and prevented from turning by a connection to the truck frame.

The pinion was mounted on a telescoping shaft provided with two universal joints, one at each end and fastened to the pinion and generator shafts by bolted flanged couplings.

The generator was mounted under the car body, the

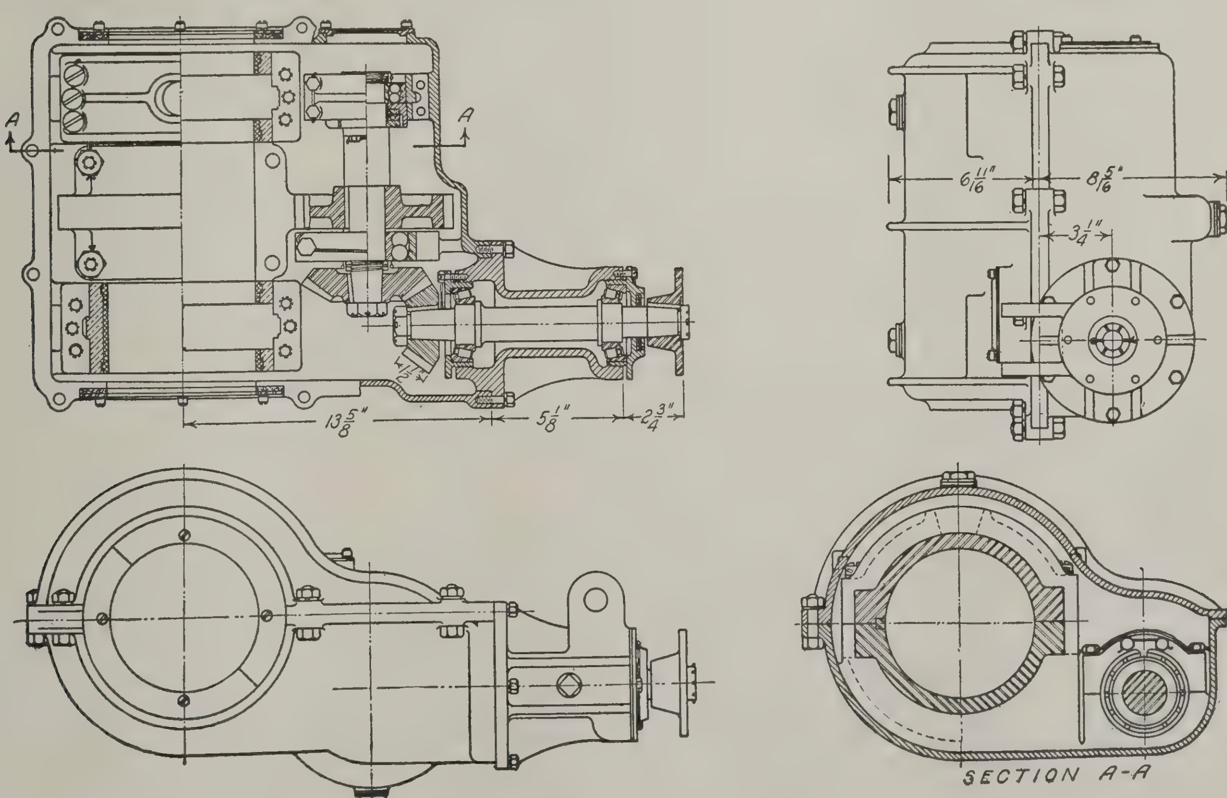


Fig. 1—Assembly Drawing of Main Part of Gould Drive

armature being parallel with the longitudinal axis of the car.

This drive was applied to Long Island R. R. car No. 336, February 6, 1912, and the following is its record of service:

April 12. Pinion bearings in gear housing worn, but gears in good shape; mileage 12,700 miles.

April 20. First bronze pinion bearings in gear housing removed; mileage 14,337 miles.

July 23. Second pinion bearing removed; mileage 15,518 miles; total mileage 29,855 miles.

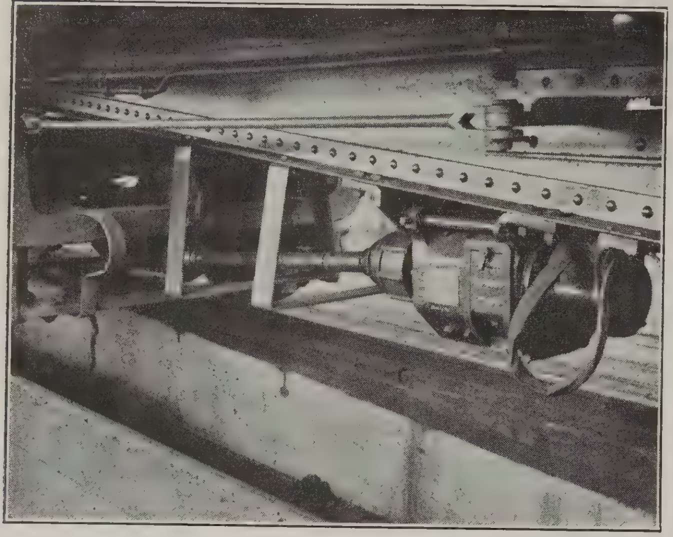


Fig. 2—Gould Direct Drive Equipment Mounted on D. L. & W. Car

August 13. Pinion bearing in housing found loose; total mileage 32,346 miles.

From this time on the main trouble was with the pinion bearing in the gear housing and plans were under way to try ball or roller bearings.

About October 1, 1912, the car was derailed and the shaft damaged. The general decision was not to go further with the test because the pinion bearings showed so much wear that ball or roller bearings would not prove satisfactory.

The drive was returned to the manufacturer on March 31, 1913.

The "Safety Car Heating and Lighting Company's" Drive

The "Safety Co.'s" second drive consists of two axle bushings, they being mounted on the axle a little inside the wheel fits. Each bushing carries a collar to which eye bolts are secured.

These eye bolts are connected by means of a helical spring, normally under tension, to a lug on a hollow shaft, the springs being approximately parallel with the longitudinal axis of the axle.

This hollow shaft has a sufficient internal diameter to permit the axle to move freely without fouling the shaft.

This shaft is split and is supported at each end by the outer raceways of four ball bearings, the inner raceways of which are mounted on short shafts carried by the gear housing.

The gear housing is split and is carried by seats turned on each end of the hollow shaft, and is prevented from turning by lugs attached to cross bars fastened to the axle generator suspension irons.

Mounted on the hollow shaft is a split gear meshing with a pinion which is mounted on a short shaft carried on ball bearings, parallel to the axle.

Mounted upon this same short shaft is a bevel gear meshing with a pinion mounted on a second shaft, also carried on ball bearings, perpendicular to the axle.

This second shaft is connected to the armature shaft by means of a split coupling, no universal joints being provided, as the generator is carried on suspension irons attached to the truck frame.

It should be noted that this drive does not require a special axle, and also that no provision has been made for maintaining the pitch circles of the bevel gear and pinion in contact.

So far as is known this drive has never been used in actual service.

The "Gould" Drive

The "Gould" Shaft Drive, shown in cuts, Figs. 1 and 2, requires the use of a special axle, as shown in the cut, Fig. 1.

A circular key, ½ inch wide and ¼ inch high, is machined on the axle midway between two bearing fits, 4½ inches long. A second key, ½ inch by ½ inch and 5¼ inches long, is fitted in a keyway cut in the axle parallel with the axis of same.

The first key acts to center the split gear on the axle and the second serves to drive the gear. The bearing fits on the axle serve as a seat for the gear box.

The 52-tooth spur gear mounted on the axle meshes with a 36-tooth spur pinion mounted on a shaft, parallel to the axle in the gear box, this shaft being carried on ball bearings.

On this shaft is a 28-tooth bevel gear, meshing with a 20-tooth bevel pinion on a second shaft perpendicular to the axle. This second shaft is carried on ball bearings

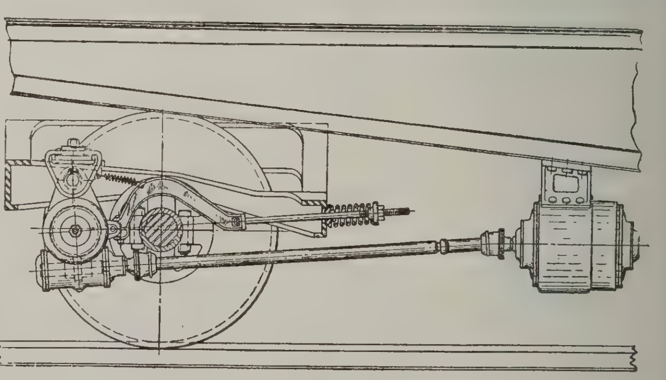


Fig. 3—Side Elevation of U. S. L. Drive

mounted in the gear box and at the outboard end carries one part of a universal coupling.

The gear box is split on the horizontal diameter of the axle and is prevented from turning by a member which connects the end of the gear box to the end frame of the truck.

A telescoping shaft carrying on one end the balance of the first universal joint and on the other end a portion of a second universal joint serves to transmit the power to the armature shaft.

Mounted on the armature shaft is a safety device con-

sisting of a coupling carrying a shear pin so that if the generator becomes damaged in any way that will throw an excessive load on the drive, this pin will shear, permitting the drive to run free. This safety device also forms the balance of the second universal coupling.

Disconnecting this safety device permits the generator to be operated as a motor for testing purposes.

The generator is mounted rigidly on the underframe of the car body with the armature shaft parallel with the longitudinal axis of the car.

Provision is made whereby the position of the bevel pinion can be adjusted so as to maintain the pitch lines of the bevel gears and pinion in contact.

The record of this drive as applied to a car on the D., L. & W. Railroad is as follows:

January 17, 1918. Car No. 582 came out of shop and went in service on local runs.

January 19, 1918. Car journal ran hot, causing car to be cut out for repairs. The opportunity was taken for inspection of internal mechanism and it was found that locking device for jack shaft adjustment had failed, and the locking pin had fallen out and into the grease. From here it traveled with the grease and got into the gears, cutting them badly before it was finally cut to pieces, but damage to gears did not necessitate removal or repair, and after cleaning out all grease and installing an improved locking device, the car went back in service on February 13, 1918, no further trouble with the locking device being experienced.

April 24, 1918. Universal on the generator was greased.

September 16, 1918. Both universals greased, and five pounds of grease put in gear box.

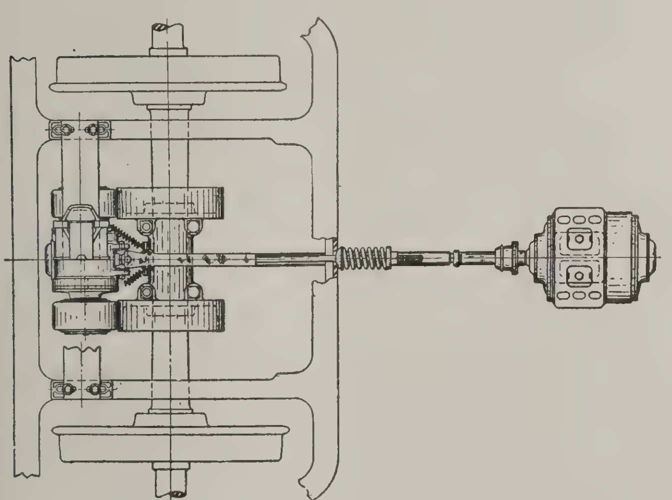


Fig. 4—Plan of U. S. L. Drive

July 19, 1919. For purposes of investigation and inspection, the device was opened up, grease cleaned out and all parts checked up for wear. No wear was noticeable on gears, axle bearings, universals, shock absorber or hangers. No dirt or residue of any kind noted in gear case. Back lash on gears normal and all parts functioning properly. All screws and bolts tight and no apparent strain in any part. Refilled with fresh grease and put back in service.

February 20, 1920. Greased universals and put five pounds of grease in gear box.

July 14, 1920. Car came out of shop and the device was opened up for general inspection. After cleaning out the grease, conditions were found as follows:

Gears. Back lash normal, wear insignificant, just enough to show point at which teeth were coming into mesh to be properly adjusted. No adjustment necessary on jack shaft.

Main Bearings. Wear slight, not enough to permit passing of 1-64 inch shim ⅜ inch wide. Thrust surface

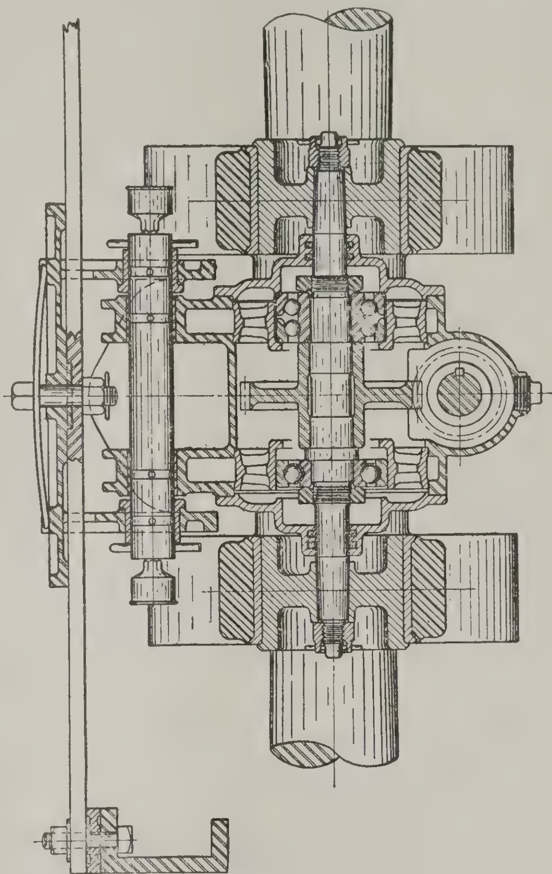


Fig. 5—Section Showing Details of Construction of U. S. L. Drive

clearance about ⅛ inch, slightly more than on previous inspection.

Dust Guards. In good shape, allowing no dirt to enter.

Universals. No wear apparent.

Telescope Joint. No wear apparent.

Suspension on Linkage. No wear apparent and free to swing.

January 25, 1921. Regreased gear box and universal shaft drive joints.

July 25, 1921. Regreased gear box and universal shaft drive joints.

February 23, 1922. Regreased gear box and universal shaft drive joints.

Eight pounds of grease were used each time.

The equipment was inspected subsequently to May 24 and considerable wear was found between main axle and intermediate gear teeth. The bevel gear showed practically no wear and was in good condition. The wear on the main gear was due to it not being hardened as was the bevel gear. At all times the drive has functioned properly, maintaining a steady voltage and amperage output according to the setting of the regulator. No noise

is made by the device when operating and the performance up to date has been very satisfactory. A mileage of approximately 100,000 has been attained and the shock and strain due to hard suburban service has been withstood without faults developing. Some improvement as to reducing weight may be possible as well as reduction in size, the present outfit being claimed large enough to drive 15 H. P.

The following is a record of the performance of a similar drive on C. & N. W. diner 2868, applied April, 1920:

Equipment operated satisfactorily until the latter part of July, 1920, when the brass collar for adjusting the rear shaft bearing became loose. Repairs were made and the

board end one portion of a universal coupling, by which connection is made to a telescopic shaft which carries on one end the balance of the above universal coupling and at the other end one part of a second universal coupling, the remainder of the second universal coupling being secured to the armature shaft.

Both sets of gears and pinions are enclosed in a split housing. The housing is restrained in the horizontal plane by a cross-head through which the shaft passes, this cross-head being carried by a "U" frame attached to the truck frame.

The housing is, however, free to move, within limits, in a vertical plane, it being at once supported and pre-

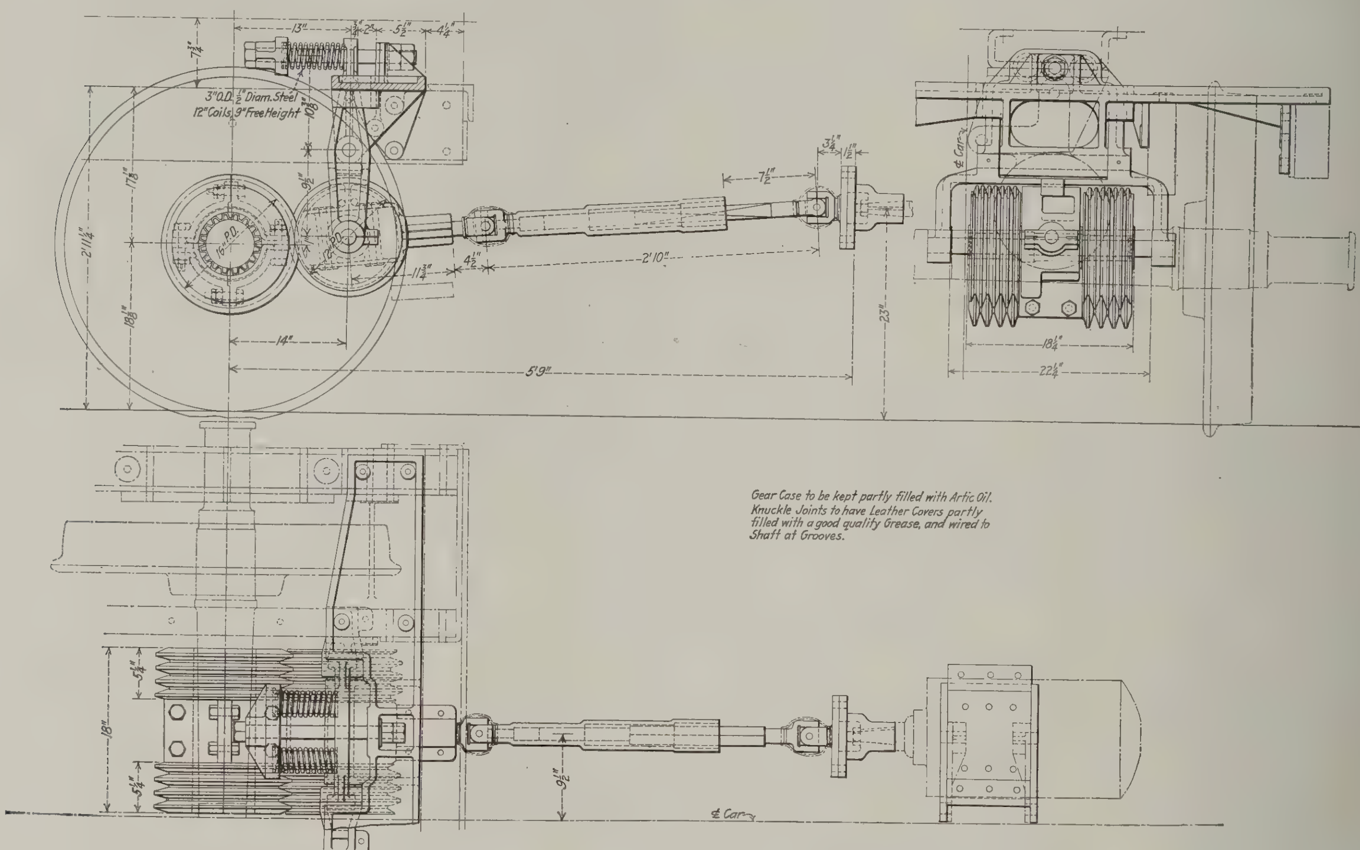


Fig. 6—Arrangement of Friction Drive for Generators, Canadian Pacific

drive worked satisfactorily until the latter part of September, 1920, when the adjusting collar again worked loose. Repairs were made and operation was satisfactory until February 15, 1921, when car was taken in shop, at which time it was found that the adjusting nut had again worked loose.

The equipment was transferred to diner 2868, which is still in shop.

From the time of application to diner 2868 until its renewal, there was no failure of lights.

The "Pitt" Drive

The "Pitt' Drive consists of a split spur gear bolted to the car axle, over which a layer of felt packing has been laid.

This spur gear meshes with a spur pinion mounted on a shaft parallel with the car axle and carried on ball bearings. On this same shaft is mounted a bevel gear meshing with a bevel pinion mounted on a second shaft, perpendicular to the car axle, and carrying at its out-

vented from turning by an inverted "U" frame, this frame being cushioned by two helical springs through which the supporting bolt passes, placed above and below the cross part of the "U" frame.

This supporting bolt at its upper end carries a short shaft on which are mounted two rollers, these rollers moving on two tracks which are formed in a casting which is secured to the underside of the car body.

So far as is known this drive has never been placed in service.

The "Matthews" Drive

The "Matthews" Drive consists of a split spur gear clamped to the axle by means of tapered wedges, drawn together with bolts so as to act as an expanding bushing.

This gear meshes with four shrouded spur pinions mounted on short shafts parallel to the axle journaled in ball bearings carried by the gear bushings and serve to support the housing.

Three of these shafts run idle, the fourth carries a

bevel gear which meshes with a bevel pinion mounted on a shaft perpendicular to the axle and journaled in ball bearings.

This second shaft is connected by means of a universal joint to an extension shaft provided with a sliding joint, and this in turn is connected to the armature shaft by a second universal joint.

The housing is at once cushioned and prevented from turning by a connection to the truck frame, the two portions of which are connected together through a helical spring, so arranged as to constrain the movement of the housing for both directions of rotation. From the cut the bevel gears are apparently run exposed to the weather and no provision is shown for maintaining the pitch circles of the bevel gears in contact.

So far as is known, this drive has never been tried out in service.

"United States Light & Heat Corporation" Drive

The "U. S. L." Drive, as shown in Figs. 3, 4 and 5, consists of a 17-inch split twin steel pulley secured to a standard axle by means of through bolts.

These pulleys drive by contact two 10-inch pulleys or friction wheels which are made of rubber tires molded on steel rims, the rims being pressed on the center hub of the pulley.

These tires are the standard tire as used on industrial automobile trucks. These pulleys are mounted on the ends of a short shaft, parallel to the axle, this shaft being supported by two sets of ball bearings which are carried from a housing pivoting about a horizontal cylindrical bar in a position approximately vertically above the pulley shaft.

This bar in turn is supported by a steel casting mounted on a member which is supported by the truck frame.

This casting is arranged so that it will pivot in the horizontal plane about a bolt, equalizing the pressure of the friction wheels on the pulleys.

At the center of the shaft carrying the friction wheels a worm wheel is mounted which meshes with a worm mounted on a second shaft perpendicular to the axle. This second shaft is also carried on ball bearings which are mounted in a casting which is bolted to the casting forming the housing for the worm wheel.

The worm shaft is connected to the shaft of the axle generator, which is mounted longitudinally under the car body by means of two universal couplings and an extension shaft with a sliding joint.

Pressure between the pulleys and the friction wheels is assured by a bar attached to the housing midway between the pulley, curved so as to pass over the axle and extending beyond the end sill of the truck and having a thread cut on the end.

Beyond the truck frame this rod passes through a helical spring and the pressure between the pulley and friction wheel is adjusted by the amount that this spring is compressed.

This drive has been operating for some time in experimental service in the shop, but has never been used in service on the road.

The Canadian Pacific Railway Drive

This drive consists of a set of cast iron discs with chilled wearing faces, bolted to the car axle in similar manner to a standard axle pulley. A long corrugated bushing is used to ensure a thoroughly tight fit.

These discs, having taper faces, engage in a similar set of discs which are suspended from the car truck, mounted on the shaft which suspends the driven discs in a chrome steel bevel gear, which drives a longitudinal shaft connected to the generator by means of two flexible couplings. Ball bearings are used throughout, and the gears are enclosed in a cast iron gear case.

The friction between the two sets of discs is maintained by means of an adjustable spring, so that, should the brakes skid the wheels, the discs will slip and prevent damage to the generator or gears. Ample side play is allowed the driven discs, which are free to follow the lateral movement of the axle, due to wear of journals, brasses, etc. The gear case is spring suspended to prevent jar to gears on rail joints or crossings.

Figure 6 shows the general layout of the drive.

The drive has run about 15,000 miles and practically no wear is noticeable on the discs. Some changes are now being made to the flexible couplings and the gear box suspension.

The George G. Milne Drive

The Milne drive is of the worm gear type, the gear and casing being mounted on the car axle. The generator is mounted longitudinally under the car body and the armature is connected to the worm by means of a shaft having universal joints and slidable connections.

There is attached to a standard car axle two split collars of somewhat special design. Mounted between these collars and at the same time resting on shoulders on the collars is a split worm gear. The opening through the gear is of larger diameter than the axle, thus leaving a space between the gear and the axle. The gear is held in place by means of bolts parallel to the axle, passing through flanges on the collars and through the gear. The collars also provide a wide bearing seat for the gear casing, which casing carries two ball bearing housings for the worm. The casing is split to permit its removal and the bottom can also be removed for inspection and greasing of the worm. A suitable connection is provided between the casing and truck frame to prevent the former from rotating. A modified design for the gear mounting and collars has also been developed.

This drive has not as yet been tried out in service.

The D. C. Wilson Drive

The Wilson drive is of the friction type. It consists of a split friction pulley mounted over a corrugated bushing on the car axle. This pulley engages in friction contact with the face of a steel disc mounted on a short ball bearing supported shaft located longitudinally with the car and attached to the truck frame. Contact between the periphery of the pulley and face of the disc is maintained by spring pressure.

The generator is mounted longitudinally under the car body and the armature is connected to the end of the disc shaft by means of a telepscopic shaft with universal joints.

A modification of the design provides for automatically controlling the speed of the generator. The friction pulley is mounted on a separate sleeve sliding over a longer sleeve attached to the car axle. By means of a suitable fly ball governor type of mechanism the pulley can be made to move automatically along the axle dependent upon the speed of rotation of the axle. This changes the speed ratio between the pulley and disc attached to the shaft driving the armature and maintains an approxi-

mately constant generator speed within certain range of the axle speed.

This drive has not as yet been tried out in actual service.

Belt Drive with Universal Pulleys

While not coming under the classification of the direct drive as defined in this report, there has been developed by the Krebs Manufacturing Company a belt drive for body hung generators using a special axle pulley known as the "Universal Split Pulley."

The pulley is designed so as to provide a universal joint type of connection between the pulley rim and hub. The width of the face of the pulley is but slightly more than that of the belt and has deep straight flanges. Two guide rollers with special mounting keeps the pulley at all times in a vertical plane but free to rotate about a vertical axis through a certain arc. Throughout the range of the swing of the truck the pulley automatically maintains its face at right angles to the line between pulley centers. The pulley is of split construction and can be readily applied to standard car axles.

One of these pulleys has been in service test on coach No. 2866 on the Chicago, Rock Island & Pacific Railroad, using 5-inch 4-ply belt. The application was made May 17, 1922, and after approximately 25,000 miles' service the belt showed no signs of edge wear or any appreciable stretch. Figure 7 shows this pulley as installed on this car.

It will be conceded by all who are familiar with present-day operation of axle generators that, at the present time, failure of the drive is the cause of a larger number of failures of light than any other one item.

The records of the company operating the largest number of axle generators show that 18.4 per cent of the lighting failures and 25.2 per cent of the equipment failures are due to the drive.

The causes of the trouble experienced with belt drive are many and various, but they are not germane to the subject assigned.

Their effect on car lighting, however, is and has been so detrimental that, as has been shown, repeated efforts have been made to design a satisfactory positive drive which would eliminate the belt.

The advantages of such a form of drive are:

1. Decreased liability of failure of drive, resulting in
2. Decreased liability of failure of light.
3. Decreased liability of deterioration of battery, due to undercharging of battery on account of the belt slipping and sulphating on account of battery becoming discharged and standing in that condition.
4. Decreased liability of having train detentions.
5. Decreased liability of annoyance to passengers, due to flickering of lights caused by belt slipping and to failure of lights due to loss of belt.
6. Positive drive under all conditions of weather.
7. Elimination of belt tension device, simplification of suspension, with consequent reduction in first cost and cost of maintenance of these parts of the equipment.

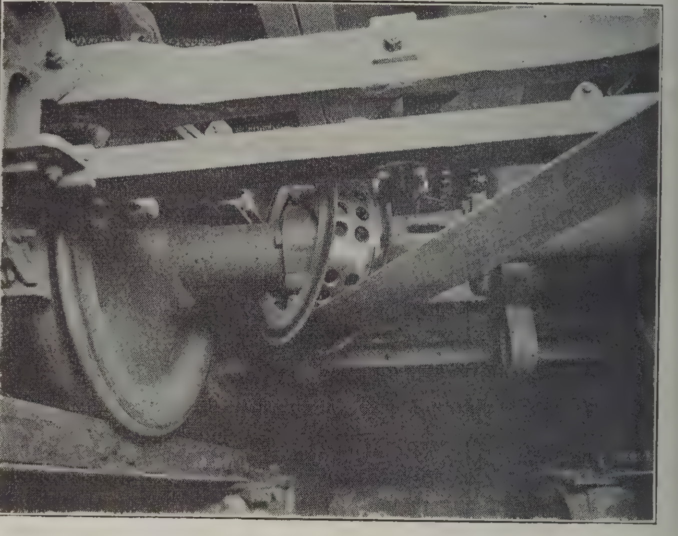


Fig. 7—Universal Joint Type of Pulley

The disadvantages of such a form of drive are:

1. Increase in first cost of drive.
2. Increase in cost of application.
3. Increase in length of time of train detention when drive does fail.

DATA ON BELTS—BODY HUNG GENERATORS

	1 K. W.			2 K. W.		
Railroad	N Y C	N & W	A C L	N Y C	N Y C	N Y C
Make of Generator	Safety	U.S.L.	Safety	Safety	U.S.L.	Gould
No. of generators in service	26	70	6	2	77	33
Type of suspension	N Y C	N & W	....	N Y C	N Y C	N Y C
Width of belt, in.	4	4	4	4	5	4
Plies of belt	4	4	5	4	4	4
Av. length of belt, ft.-in.	15	15	13	15	14-7	14-7
Type of fasteners	C	W	C	C	C	C
Diam. of axle pulley, in.	19	17	17	19	19	19
Diam. of armature pulley, in.	8	6.5	5.5	8	10	8
Belt renewals in % of cars equipped:						
October, 1919	8	....	....	....	26	39
November, 1919	38	....	....	....	47	42
December, 1919	46	....	....	....	100	85
January, 1920	70	5.4	50	50	205	218
February, 1920	35	8.6	66	50	102	106
March, 1920	27	7.3	50	....	58	63
April, 1920	15	8.6	16	....	48	60
May, 1920	35	7.3	66	....	31	30
June, 1920	15	5.4	84	....	38	30
July, 1920	23	4.3	33	....	36	36
August, 1920	42	5.4	0	50	40	27
September, 1920	11	2.7	33	50	41	60
October, 1920	....	1.3	0	....	....	....
November, 1920	....	5.4	66	....	....	....
December, 1920	....	7.3	33	....	....	....
Total belts applied	95	49	30	4	593	264
Av. % renewals per month	30.4	5.8	41.7	16.7	64.2	66.6
Av. miles per belt	13,759	84,775	....	5,132	8,929	7,822

	3 K. W.										
Railroad	N Y C	B & O	B & O	B & O	D L & W	I C	I C	I C	A C L	A C L	A C L
Make of Generator	Gould	Safety	Stone Franklin	U.S.L.	Gould	Safety	Gould	Gould	Safety	U.S.L.	Stone Franklin
No. of generators in service	84	60	92	50	129	126	84	237	11	10	7
Type of suspension	N Y C	und. frame	Stone	U.S.L.	....	und. frame	Gould	1 C	....	....	....
Width of belt, in.	5	4	4	4	4	4	4	4	4	4	4
Plies of belt	4	5	4	5	5	4	4	4	5	5	4
Av. length of belt, ft.-in.	14-7	14-5	15	14-9	....	13-6	13-6	14	14-6	13	13
Type of fasteners	C	W	W	C	C, W	W	W	C, W	C	C	W
Diam. of axle pulley, in.	19	17	17	17	18	17	17	20	17	17	17
Diam. of armature pulley, in.	8	5.5	5.5	8	....	5.5	8	11	5.5	8	5.5
Belt renewals in % of cars equipped:											
October, 1919	30	....	....	....	....	....	....	....	....	....	....
November, 1919	8	....	....	....	....	....	....	....	....	....	....
December, 1919	64	120	69	58	....	35.5	31.6	13	....	....	....
January, 1920	140	113	69	42	40.5	120	74	57	64	80	29
February, 1920	75	77	67	70	30.5	65	61	24	64	240	43
March, 1920	69	62	64	42	31	67	44	19	73	150	85
April, 1920	41.5	93	70	30	14	43	51	24	110	20	100
May, 1920	31	113	54	48	8.5	47	45	12	45	30	29
June, 1920	21.5	125	61	38	21.6	55	45	19	64	50	29
July, 1920	22.5	88	48	36	31	54	57	22	91	70	29
August, 1920	28.5	62	73	58	19.4	50	61	23	100	20	14
September, 1920	21.5	75	44	28	4.7	51	55	19	54	20	29
October, 1920	....	50	55	10	3.9	57	52	23	54	70	29
November, 1920	....	50	76	26	16.2	64	44	20	110	50	43
December, 1920	....	....	....	....	17	....	....	....	128	50	43
Total belts applied	463	617	694	244	307	894	520	655	105	85	35
Av. % renewals per month	45.9	85.6	62.7	40.7	19.8	59.1	51.5	23	79.5	70.8	41.6
Av. miles per belt	7,257	....	....	....	....	17,000	20,000	44,000	....	....	....

4. Increased difficulty in testing generator by motoring.

To be really successful, the direct drive should, of course, in addition to its advantages over the belt drive, be capable of being operated at a total cost comparable with the total cost of operating the belt drive.

In order to determine what the cost of operating a belt drive might be, your Committee presents the accompanying data as furnished by various railroads, from which it will be noted that the mileage per belt varies from 5,132 to 84,775, and that the average percentage renewals per belt per month vary from 5.8 to 85.6.

As these figures vary so widely on the several railroads, each railroad should, when making such a comparison, make use of its own data.

However, as a guide to arrive at a figure which might represent the cost of operating, we submit the following:

Assumptions

Miles service per belt	10,000	
Miles service per month per car	5,000	
Length, width and ply of belt	14 ft. 0 in. by 4 in. by 5-ply.	
Cost per foot of belt	$0.4725	
Type of belt fastener	Crescent	
Cost of fasteners per belt	$0.155	
Axle pulley bushing, life, cost	20 yrs.	$4.95
Axle pulley life, cost	10 yrs.	18.00
Armature pulley life, cost	3 yrs.	12.00
Armature pulley times turned, cost per turning	3	.90
Labor to cut and apply belt, time, cost	20 min.	.28
Difference in cost of suspension, including belt tension device		75.00

Cost per year based on above Assumptions.

Operation

6-14 ft. 0 in. by 4 in. by 5-ply belt, at $0.4725 per foot	$39.69	
6 sets of fasteners, at $0.155 per set	.93	
6 by 20 minutes for application belt, at $0.85 per hour	1.70	
Cost of one turning of armature pulley	.90	
		$43.22

Depreciation

Axle pulley bushing, $0.05 by $4.95	$0.25	
Axle pulley, $0.10 by $18.00	1.80	
Armature pulley, $0.33 by $12.00	4.00	
		$6.05

Interest

Axle pulley bushing at	$4.95	
Axle pulley at	18.00	
Armature pulley at	12.00	
Belt at	2.84	
Fastners at	.06	
Difference in cost of suspension	75.00	
Interest at $0.06 on $112.85		6.77
Total		$56.04

Therefore, as an economical proposition, considering the drive only, the direct drive, on the basis of the figures used in making this comparison, should be capable of being operated at a total cost, counting in operation, maintenance, depreciation and interest at not more than $56.00 per year.

There are, however, other items of expense due to the use of the belt drive which must be considered in making a true comparison.

These items are:

1. Cost of charging current at terminals necessitated by car arriving with batteries discharged due to belt slipping or being lost.

2. Depreciation of battery due to sulphation on account of battery being discharged and remaining for a greater or less time in that condition, due to belt slipping or being lost.

3. Depreciation of battery due to "reserve" material being formed into "active" material before needed, due to sloughing off of sulphated active material and "forming" charge resulting from low current to battery caused by slipping of belt.

4. Loss of patronage due to annoyance to passengers caused by the "flickering" or failure of the lights due to defects of the belt drive.

Objections 1, 2 and 3 may, but do not necessarily, apply to generators designed to operate with slipping belt.

The points that , in the judgment of your Committee, should be avoided in designing a positive drive for axle generators are:

1. Construction which necessitates the use of a "special" axle.

2. Construction which in any way changes a "standard" axle.

3. Construction which necessitates the removal of the wheel from the axle in order that the equipment may be applied.

4. Construction which uses a helical spring in a plane other than that perpendicular to its axis.

5. Construction which, on account of wear, necessitates scrapping of material other than the material worn.

6. Construction which does not provide for maintaining pitch circles of bevel gears in contact.

7. Construction which does not readily permit the turning of wheels in center drive wheel lathes.

8. Construction which does not provide for the full movement of the axle in all planes.

9. Construction that does not provide efficient lubrication and protection to all working surfaces from dirt and grit.

The points that, in the judgment of your Committee, should be provided in the design of a positive drive for axle generators are:

1. Connection to axle that can readily be removed.

2. Mounting of the axle generator on the truck or underframe of car in the simplest possible manner.

3. That the universal joints, if used, should have a free angular movement in any direction in excess of the angle between center lines of truck and car body as found on the curve of least radius over which the car is capable of moving in service condition.

4. That a safety device should preferably be provided which will operate to break the connection between the drive and generator, in the event of the drive tending to become overloaded.

5. That the generators should be so mounted as to provide a maximum of accessibility.

6. That means should be provided by which the generator may be readily "motored."

Your committee feels that at the present time there is no type of direct or positive drive which does not include features that are objectionable to the extent of practically prohibiting its general use, nor does any drive possess all of the points that we consider necessary.

Your Committee is however, of the opinion that the advantages of the direct drive are of such importance as to justify its further development and further that its use would be justifiable even at a cost in excess of the belt drive.

Your Committee believes that there is a demand for a direct or positive drive and that its development should be encouraged by all concerned.

Specifications for Axle Generators—1920 Report

There has been more or less criticism of regulation limits as given for the lamp regulator in these specifications under the heading "6. Lamp Regulator (i), 1 and 2."

As 1 now reads the greater the load on the regulator the greater the permissible drop in voltage.

Due to the characteristics of the battery, the terminal voltage of the battery also decreases as the load increases.

Therefore, we have incurred a double drop in lamp voltage, while what is actually desired is a constant lamp voltage.

As this condition is impossible of attainment under the conditions given, i. e., a battery voltage of 31 volts or less, the obvious thing to do is to set a limit for the maximum conditions which will give the greatest drop permissible and for any conditions less than the maximum, the drop in voltage will then be less.

Your Committee has therefore agreed that paragraph 6 i. 1 should read as follows, the words in parentheses being those of the present text that we eliminate:

> "6 i. 1. With the battery discharging and with the battery voltage 31 volts or less, the drop in voltage across the terminals of the lamp regulator resistance shall not exceed 1 volt (per 25 amperes flowing) for the connected lamp load."

Paragraph 6 i. 2 gives certain voltage limits for a current value to be specified by the railroad company and the note recommends that this current value be 125 per cent of the connected lamp load. There is no necessity for specifying a load greater than will be encountered in service.

Your Committee has therefore agreed that paragraph 6 i. 2 should read as follows, the words in parentheses being those of the present text that we eliminate:

> "6 i. 2. With armature r. p. m. increasing at an approximately uniform rate from minimum load speed to maximum speed in not more than five minutes and again decreasing to its original value, the voltage shall be maintained at . . . volts plus or minus one volt (at any current value not exceeding . . . . amperes) at any current value equal to or less than the connected lamp load."

Recommended Subjects for Further Investigation

The Association has adopted as a recommended practice that axle pulley bushings, if they are used, be 7½ inches in diameter and not less than 8½ inches long. It appears that the dimensions for these bushings have not been covered in sufficient detail, as it has been found there is a demand for a considerable number of types and sizes of bushings, the variation between them being slight. This condition has tended to increase the cost and prevent the manufacturers from making up bushings for stock.

Your Committee believes that it would be of considerable advantage to the railroads to standardize the sizes of the corrugated type of steel axle pulley bushings and recommends that this subject be investigated with a view to determining the minimum number of sizes required and establish the essential dimensions for these sizes.

Considerable interest is now being manifested in wide face type of axle pulleys, especially for use with body hung generators. The expense for developing pulleys of this type is appreciable. If there is a probability of their being used to any wide extent it is of decided advantage to the railroads to have available some few standard designs which can be manufactured in sufficient quantities to keep the cost within reasonable limits. Your Committee recommends that this subject be investigated, obtaining data on belt performance results that are being secured with this type of pulley and establishing at least tentatively the essential dimensions for standard pulleys of this type.

Respectfully submitted,

COMMITTEE ON TRAIN LIGHTING EQUIPMENT AND PRACTICE.

Report on Locomotive Headlights and Classification Lamps

Committee and Manufacturers Meet to Consider the Factors Leading to the Development of Standard Practices

Committee:

L. C. Muelheim, chairman, chief headlight supervisor, Baltimore & Ohio Railroad; J. L. Minick, assistant engineer, Pennsylvania System; E. W. Jansen, electrical engineer, Illinois Central Railroad; F. J. Hill, chief electrician, Michigan Central Railroad; C. R. Sugg, electrical engineer, Atlantic Coast Line.

TO THE MEMBERS:

Approval of the plan to work jointly with the manufacturers of headlight turbo-generators and the Headlight Committee of the American Railway Association in developing certain standard practices was given your Committee at the 1920 Convention, and in addition it was found advisable to include manufacturers of ball bearings, hearty co-operation and valuable assistance being received from all.

The resulting recommendations for each of the subjects referred for development with additional recommendations for brush holders and spacing of bolt holes in base of headlamp cases are herein submitted for your consideration, it being understood, where the recommendations necessitate redesigning, that they will apply to future construction only.

The lack of uniformity in number as well as location of supports or feet on the various makes and types of turbo-generators which is illustrated in Fig. 1 renders interchange difficult, and is detrimental to the best interests of manufacturers as well as objectionable to the rail-

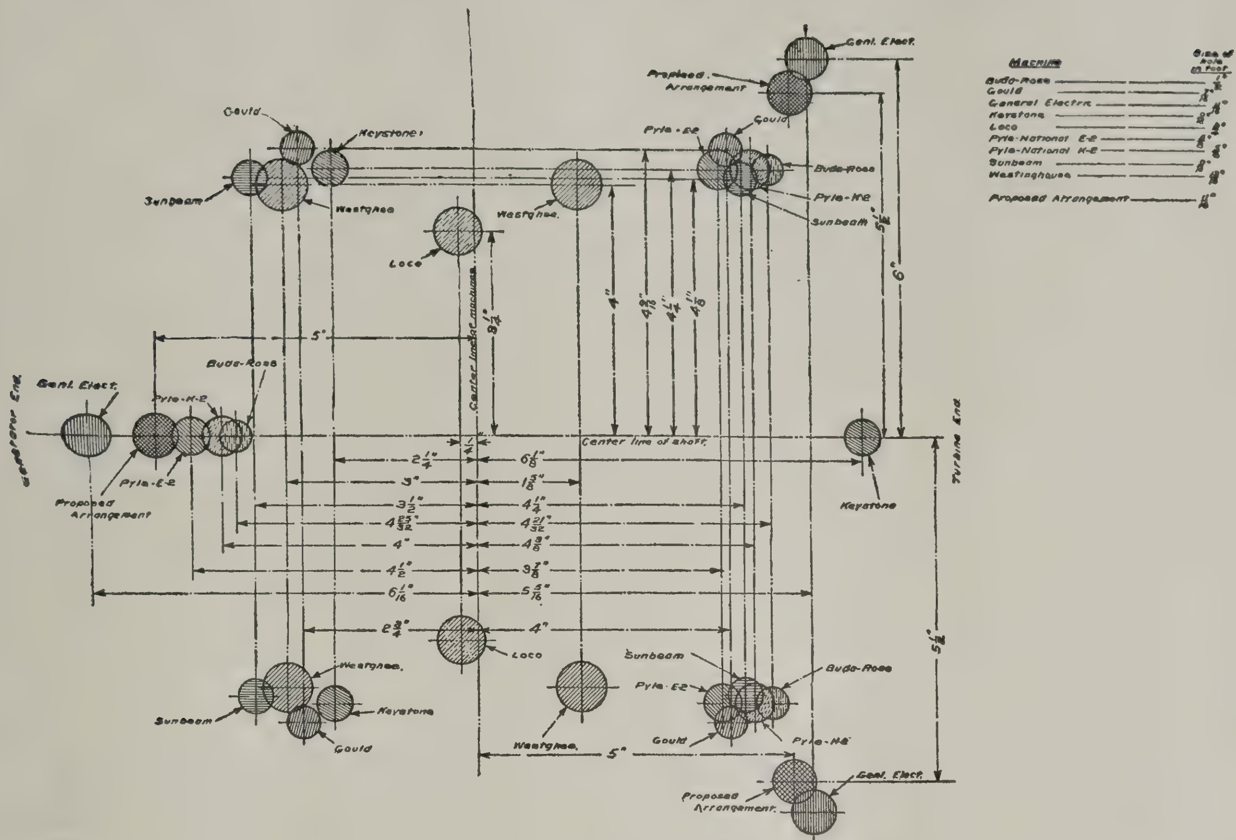
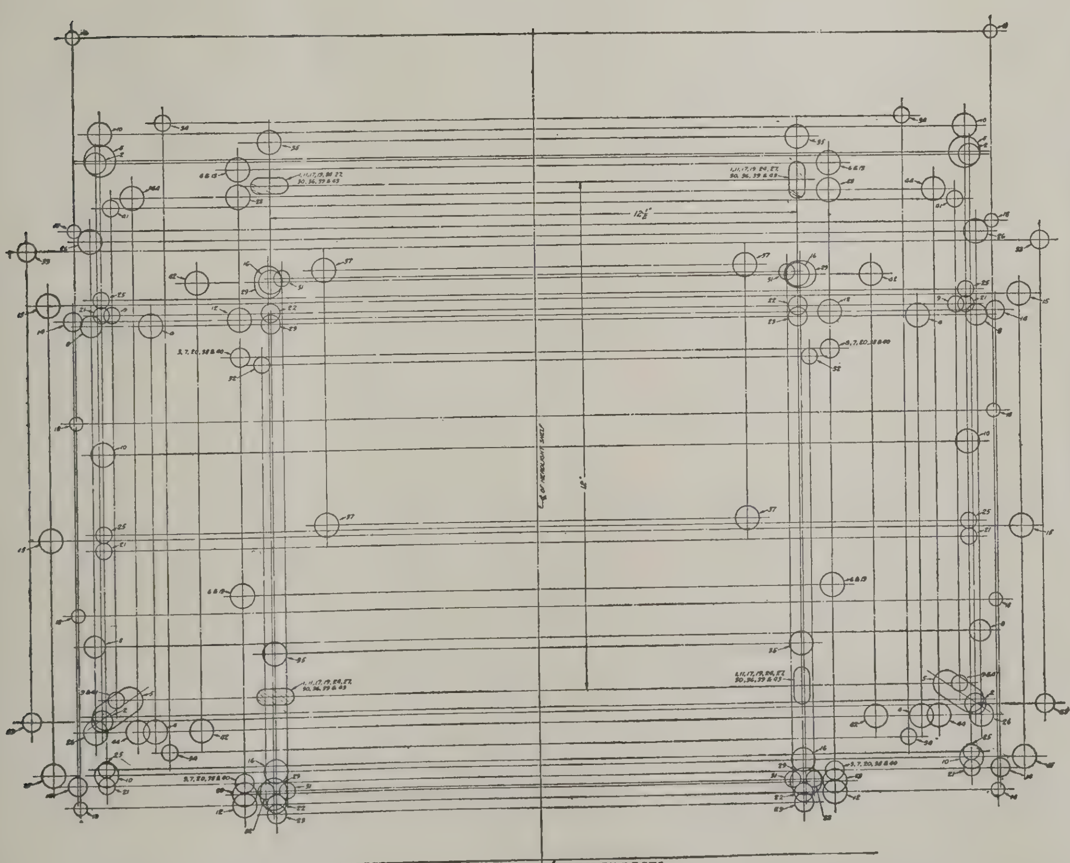


Fig. 1—Location of Supports on Turbo Generators



NO	RAILROAD	REMARKS
1	MICHIGAN CENTRAL	STANDARD FOR ELECTRIC
2	MICHIGAN CENTRAL	OIL & CONVERTED
3	N.Y.C.R.R & M.C.R.R	U.S.R.A. 2-8-2 & 0-8-0 TYPES
4	NEW YORK CENTRAL	STD. FOR 18" HEADLIGHTS
5	NEW YORK CENTRAL	STD. FOR 18" HEADLIGHTS LOCATED ON TOP OF SMOKE BOX
6	NEW YORK CENTRAL	STANDARD FOR ELECTRIC
7	NORTHERN PACIFIC	U.S.R.A. LOCOMOTIVES
8	NORTHERN PACIFIC	STANDARD
9	MISSOURI, KANSAS & TEXAS	MIKADO TYPE
10	MISSOURI, KANSAS & TEXAS	PACIFIC TYPE
11	LEHIGH VALLEY	STANDARD
12	LOUISVILLE & NASHVILLE	FOR SCHROEDER HEADLIGHT
13	ERIE	STANDARD
14	GRAND TRUNK	STD. FOR ENGINES WITH CYLINDERS 19 AND OVER EXCEPT CLASS P
15	CHICAGO & NORTHWESTERN	STANDARD
16	WABASH	STANDARD
17	PERE MARQUETTE	STANDARD
18	PENNSYLVANIA	CONVERTED OIL HEADLIGHTS
19	NEW YORK, NEW HAVEN & HART'D	STANDARD
20	NEW YORK, NEW HAVEN & HART'D.	U.S.R.A. LOCOMOTIVES
21	SOUTHERN PACIFIC	STANDARD
22	TEXAS & PACIFIC	STANDARD (ON FRONT END)
23	TEXAS & PACIFIC	STANDARD (TOP OF SMOKE BOX)
24	DELAWARE & HUDSON	STANDARD
25	UNION PACIFIC	STANDARD
[illegible]	SANTA FE	STANDARD
27	BESSEMER & LAKE ERIE	STANDARD
28	BUFFALO, ROCHESTER & PITTSBURG	STANDARD (EXCEPT ON MALLETS)
29	CHICAGO, MILWAUKEE & ST PAUL	STANDARD
30	CENTRAL OF GEORGIA	STANDARD
31	C.R.R. OF NEW JERSEY	PYLE NATIONAL & GLAZIER 18"
32	C.R.R. OF NEW JERSEY	DRESSEL 18"
33	CHICAGO, BURLINGTON & QUINCY	STANDARD
34	CANADIAN PACIFIC	STANDARD
35	CANADIAN PACIFIC	STANDARD
36	D L & W	STANDARD
37	NORFOLK & WESTERN	STANDARD (ON FRONT END)
38	RUTLAND	STANDARD
39	DELAWARE & HUDSON	STANDARD (PYLE NATIONAL)
40	DELAWARE & HUDSON	STANDARD (SCHROEDER)
41	ILLINOIS CENTRAL	STANDARD
42	BALTIMORE & OHIO	STANDARD
43	BOSTON & ALBANY	STANDARD
44	CHICAGO, ROCK ISLAND & PACIFIC	STANDARD
	GREAT NORTHERN	NO DRAWINGS
	VIRGINIAN	NO DRAWINGS
	ST. LOUIS & SAN FRANCISCO	NO DRAWINGS
	ATLANTA & WEST POINT	NO DRAWINGS
	CHICAGO & ALTON	NO DRAWINGS
	CANADIAN NATIONAL	NO DRAWINGS
	SOUTHERN RAILWAY	HOLES LOCATED TO SUIT
	CHICAGO GREAT WESTERN	HOLES LOCATED TO SUIT
	NICKEL PLATE (N.Y.C. & St.L.)	NO STANDARD
	ATLANTIC COAST LINE	NO STANDARD

Fig. 2—Bolt Spacing for Base of Headlamp Cases

roads. The spacing recommended can be adopted to future designs without much difficulty, thus overcoming the present chaotic situation.

The recommendation for the location of the steam inlet may appear to allow the manufacturer more latitude than is desirable but to fix a definite location appeared to be an unnecessary handicap in the freedom of design. With the variation in location of steam inlet from the longitudinal and transverse center line of bolt spacing and vertically above the base plate in increments of one-half inch, any make of turbo-generator can be applied without the necessity of changing the steam pipe from the boiler by using standard fittings and proper lengths of pipe nipples, standard lengths of which vary by one-half inch increments.

The restriction of turbo-generator manufacturers to one size of ball bearing was likewise considered as unnecessarily hampering future development and particularly with reference to the design of the shaft. Much of the ball bearing trouble that is being experienced can be attributed to

1. Rotating parts out of balance.
2. Shaft running near the critical speed, producing excessive vibration.
3. Shaft loose in bearings which, when existing, rapidly increases.
4. Shaft too small which, when attachments thereto are out of balance, springs out of line to seek its balance, thus throwing bearings out of alinement.
5. Faulty design of bearing housing, which permits dirt to work into bearings. This condition is aggravated by centrifugal action of revolving parts, creating a tendency to discharge air through all possible outside openings and draw in air near center of shaft carrying dirt with it.

Shafts of larger diameter with a higher critical speed are less liable to distortion on account of parts out of balance, and with a range of the following three sizes of ball bearings (the principal dimensions being given in inches) which the ball bearing manufacturers agreed could be expected to give satisfactory results, a greater opportunity is afforded the designer to overcome the difficulties enumerated than would be the case if he were restricted to one size of bearing.

Bearing Number	Outside Diameter (Base of Housing)	Inside Diameter (Diam. of Shaft)	Width of Race	Size of Ball
306	2.8347	1.1811	.748	7/16
308	3.5433	1.5748	.9055	9/16
406	3.5433	1.1811	.9055	11/16

NOTE.—The size of ball refers to one make only but other makes will not be greatly different.

A method of overcoming the possibility of dirt working into the bearings is a problem yet to be worked out by the designers of turbo-generators, and in this connection suggestion has been made that some form of air inlet near the center of the shaft be provided in such a way that the incoming air would not pass through the bearings, also that a pressed steel disc carried by the shaft running close to a pressed steel disc carried by the housing would soon fill with grease and form an effective dirt seal.

Experience has demonstrated that oil is best for lubrication. It should be as light as possible, consistent with the conditions of heat under which it operates, but not so light that there will be excessive evaporation. The best results will be obtained if the oil is filtered and kept in a covered receptacle.

The bolt spacing for base of headlamp cases, while not one of the subjects originally referred to this committee, was considered advisable to standardize if possible and it is believed that the recommended spacing, 12½ in. crosswise by 12 in. lengthwise, see Fig. 2, can be readily adapted to all designs. Where a railroad's standard location for headlamp is on the top or near the top of smoke box, and the recommended bolt spacing will bring the top of the headlight casing above clearance limits, the transverse spacing of bolt holes can be changed to 14 inches, but as there are so few railroads where this condition exists, it was not considered necessary to cover this condition in the recommendation, it being believed advisable to leave the matter to the railroads affected to arrange with the manufacturers.

In this committee's report to the 1920 convention, reference was made to headlight reflectors that were being developed which would not require as constant attention to keep clean as is the case with the silver-plated copper reflector, a large number of such reflectors of crystal and uranium glass with silvered backs and varying in diameter from 12 inches to 16 inches, the size most commonly used being 14 inches, have been in service a sufficient length of time to demonstrate the permanency of their reflecting value, and the small expense required to keep them clean.

It is to be regretted that no official tests have thus far been conducted on glass reflectors for locomotive headlight service, as a number of railroads have hesitated to use this type for fear of not being able to fully meet the requirements of the Division of Locomotive Inspection of the Interstate Commerce Commission. However, from information received of such unofficial tests as have been made, and the satisfactory results obtained from the glass reflectors that have been in actual service, there seems to be no doubt that a properly constructed, ground glass reflector of approximately 14 inches diameter, when used in conjunction with the standard headlight lamps will produce ample illumination to meet the headlight requirements, in addition to affording the advantages of permanency of reflecting value and small cleaning expense. The replacing of metal reflectors by the glass type, as the former became unfit for service, is therefore recommended, as well as the adoption of the glass reflector in connection with the purchase of new equipment. Suitable adapters can be arranged to mount the glass reflectors in the old metal reflector headlight cases where this is desired.

Consideration has been given to the advisability of using cab lamps of smaller dimensions, with the idea of reducing the size of lamp cases and the lamp manufacturers are co-operating in an endeavor to produce a satisfactory 15-watt S-14, 33 volt lamp to be used in place of the present S-17 lamp, but the development has not advanced sufficiently to warrant other than mention. The S-14 lamp is approximately 11/16 inch shorter and ⅜ inch smaller in diameter than the S-17 lamp.

A number of new and commendable styles of headlight cases have been developed by the manufacturers since the last convention, lightness of weight coupled with durability being dominant features, although other noteworthy refinements have been accomplished, all of which designs incorporate the glass reflectors. Your Committee has not thought it advisable to consider the standardization of the headlight case, other than with respect to the bolt hole spacing of the base, but it is recommended that the

matter be developed as to the practicability of an interchangeable glass reflector unit for cast metal headlight cases of various manufacture.

Since recommendation of the longitudinal location of the turbo-generator on the side of the locomotive boiler certain objection has been raised as a result of unsatisfactory experience on a few of the railroads using this location. As considerable diversity of opinion exists in connection with this subject it is recommended that the matter be fully investigated with a view to determining as to whether or not the previous recommendation should stand or be withdrawn or modified.

In considering standardization of bearings for turbo-generator service, ball bearings have been the only type to receive consideration. Roller bearings, however, have been so developed as possibly to have merits in connection with this equipment and this type it is felt should also receive consideration by the Committee.

The matter of signal lamps on locomotives is still unsettled, and as no decision has as yet been reached by the American Railway Association regarding the features of this subject covered by your Committee's 1920 report it is recommended that the matter be again brought to the attention of the above mentioned association with a view to clearing up the points in question at the earliest possible time.

Regarding the photometering of headlight reflectors, it is recommended that a standard detail method of procedure be established for photometering in order that uniform results may be obtained and permitting of comparison of the characteristics of various makes and types of reflectors.

There will be found at the end of this report several recommendations for maintenance practice for your consideration, and, while the recommendations submitted at this time are few, it is hoped that the start that has been made will eventually result in the formulation of a set of maintenance regulations which will be of assistance to the railroad in obtaining best possible results from the electric lighting equipment on locomotives.

Your Committee would recommend that the following be adopted as recommended practice for future designs, and to be added to recommended practices previously adopted:

1. Turbo-generators to have three feet for support and attachment to base plate, thickness of feet at bolt hole to be ¾ inch and ribbed on sides to engage head of bolt to prevent turning, ribs to extend to body of generator to strengthen the feet, holes in feet to be 11/16-inch diameter for ⅝-inch bolts, bolts to enter from the top with nuts on under side of base plate. Bolt hole spacing to provide for one bolt at generator end on longitudinal center line of machine 5 inches from transverse center line and two holes at turbine end on opposite sides 5½ inches from longitudinal center line and 5 inches from transverse center line.

   Where clearance between foot and body of generator prevents entering bolt from top, foot may be slotted, but where it is necessary to slot all feet slot in foot at generator end should be parallel with longitudinal center line and slot in feet at turbine end parallel with transverse center line.

2. Steam inlet of turbo-generator to be for ½-inch iron pipe, exhaust outlet to be for 2-inch iron pipe and drain to be for ½-inch iron pipe.

3. The variation in location of steam inlet from longitudinal and transverse center lines of bolt spacing, and the distance above the base plate to be in increments of ½ inch, steam inlet to be on left side facing turbine end.

4. Ball bearings to be any of the following numbers, which also designate the size:

   No. 306 No. 308 No. 406

5. Brushes to be 1 inch wide, ½ inch thick and not less than 1½ inches long.

6. Brush holders to be equipped with springs so designed that no adjustment is necessary or possible during the full life of brush and commutator and to provide uniform pressure during 1-inch wear of brush. Brush holders to be machined inside, set 3/32 inches from commutator and at an angle of 10—degrees.

7. Bolt spacing for base of headlight casings to be 12 inches by 12½ inches, the center line of back holes to be not more than 5 inches ahead of rear of case, bolt holes to be 7/16-inch diameter for ⅜-inch bolts, general design of casing to permit bolts to be applied from top with nuts on underside of bracket.

8. Screw sizes smaller than No. 12-28 thread not to be used, heads to be either fillister or flat and material to be brass or steel. For sizes larger than No. 12 use ¼-inch—5/16-inch—⅜-inch, etc., bolt sizes, heads of ¼-inch and 5/16-inch bolts to be slotted to permit use of screwdriver.

9. Lubrication for turbo-generators to be oil.

10. Adoption of glass reflectors for replacing worn out metal reflectors and for purchase of new equipment.

Your Committee also recommends the following for maintainenance of headlight turbo-generators:

1. Oil for lubrication to be as light as possible consistent with the conditions of heat under which used, to be filtered before using and kept in a covered receptacle.

2. Oil reservoirs to be kept free from accumulation of grit and dirt.

3. Extensive repairs and particularly repairs to rotating parts to be done only at shops or designated points where adequate facilities are available.

It is further recommended that your Committee continue to work in co-operation with the A. R. A. Headlight Committee.

Respectfully submitted,

Committee on Locomotive Headlights and Classification Lamps.

The bearings are the mechanical heart of electrical machines, and oil is their life blood. If the circulation ceases, the patient promptly dies. When the patient happens to be the bearing of a large rotating machine, the heat developed leaves little doubt as to the ultimate destination of the departed spirit.

Press dispatches from Geneva are authority for the statement that a Swiss engineer named Durler has been appointed director of works for the electrification undertakings planned by the Japanese State Railways.

I. C. Adapts Electrification to Terminal Traffic

Extended Investigation Leads to Selection of 1,500-Volts Direct Current with Overhead Contact

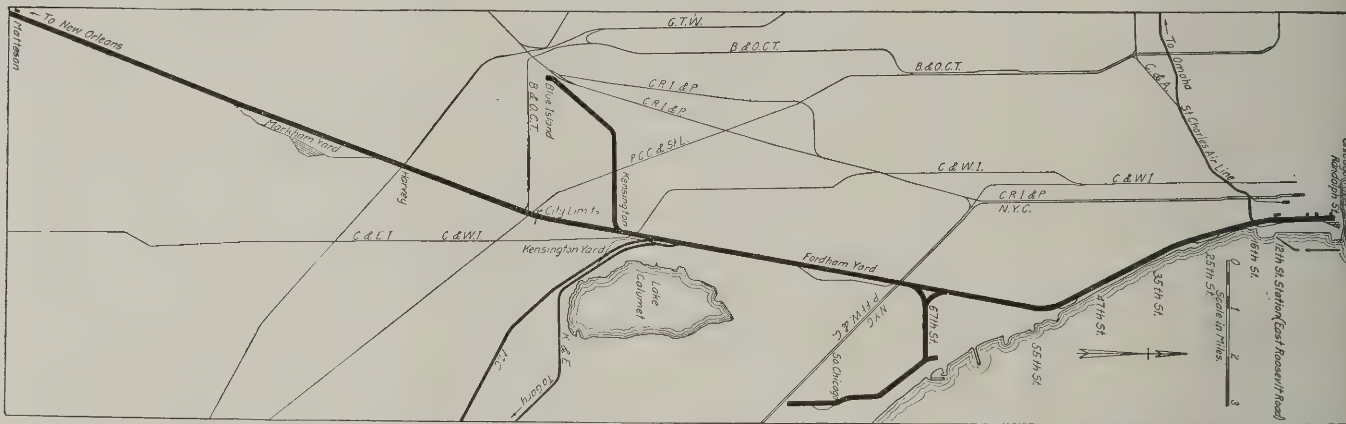
THE proposed electrification of the Chicago terminals of the Illinois Central, involving heavy suburban traffic, freight transfers and interchanges, yard switching, and later the operation of through passenger trains, wholly within a terminal area, is a combination that has not been met heretofore in electrification problems. Considering the wide variation in the fundamental features of various important electrifications the final decision of the Illinois Central to use 1,500-volts direct current with the overhead contact system, after an extended investigation which has been characterized by its thoroughness, is highly important.

Territory Involved in Electrification

In addition to its own trains the Illinois Central handles with its locomotives all of the passenger and freight traffic of the Cleveland, Cincinnati, Chicago & St. Louis from Kankakee, Ill., to Chicago, a distance of 54 miles. The Michigan Central also has trackage rights over the Illinois Central from Kensington into the city by means of which it handles its trains into Chicago with its own power although its freight house is located on the Illinois Central tracks and other facilities including the main passenger terminal at Roosevelt Road are owned by the Illinois Central. In addition to these trains the Illinois Central also handles five northbound and six southbound passenger trains of the Chicago, Lake Shore & South Bend between Kensington and Randolph street terminal. The St. Charles Air Line, running west from a connection with the Illinois Central at Sixteenth street, over which the Illinois Central operates west to Omaha, is not included in the electrification program.

According to the city ordinance covering this project, all suburban trains on lines to the south are to be operated electrically by 1927, the freight service north of East Roosevelt Road must be electrified by 1930 and the entire freight service within the city limits by 1935. The through passenger service within the city limits may, with certain provisions, be operated electrically by 1940.

The electrification for suburban service will include all suburban tracks between the suburban terminal at Randolph street and Sixteenth street; six tracks from Sixteenth street to Forty-seventh street; four tracks from Forty-seventh street to Sixty-seventh; three tracks from Sixty-seventh street to Kensington; and two tracks from Kensington to Harvey; the branch from Kensington to Blue Island; two tracks from Harvey to Matteson, which may also be used for steam passenger service; and two tracks from Sixty-seventh street to South Chicago. The route mileage involved is: Chicago to Matteson, 28 miles; South Chicago branch, 4.5 miles, and the Blue Island branch 4.4 miles, with a total of approximately 125 track miles.



Map of the Chicago Terminal District of the Illinois Central Showing Lines to Be Electrified

Traffic Study Foundation of Terminal Development

As early as 1881 the Illinois Central operated 44 trains daily in suburban service between the old Central Station, then located at Randolph street, and Grand Crossing, near Seventy-eighth street, a distance of 8.5 miles, while 15 of these trains were run on to Kensington, 6.5 miles farther, which was then the limit of the suburban zone. During the World's Fair in 1893, extensive suburban service was installed to handle the heavy traffic to and from the fair grounds, which were located adjacent to the Illinois Central tracks between Fifty-sixth and Sixty-seventh streets.

With the rapid growth of population in the area served, the Illinois Central has continued to show a steady increase in business, the approximate number of revenue passengers handled each year since 1905 being given in the following table:

1905	13,100,000	1915	13,150,000
1906	13,800,000	1916	14,100,000
1907	13,600,000	1917	13,700,000
1908	11,950,000	1918	12,850,000
1909	12,150,000	1919	15,250,000
1910	13,750,000	1920	19,000,000
1911	13,335,000	1921	19,800,000
1912	13,750,000	1922	21,000,000 —or more.
1913	13,550,000		
1914	12,750,000		

It is important to note that these figures do not include

the non-revenue employee traffic amounting to over 3,000,000 passengers for 1921, or an average of something like 8,900 a day.

Of the some 73,000 passengers carried on ordinary week days, about 42,000 are carried between 6 and 9 o'clock in the morning and between 3 p. m. and 5:30 p. m. A count on a certain day showed 10,714 passengers departing from Randolph street between 3 p. m. and 5:30 p. m., which together with 7,808 from Van Buren street made a total of 18,522 or 124 passengers a minute. During 15 min. of the peak rush from 4:30 p. m. to 4:45 p. m., there were 3,800 passengers or 253 a minute. During this evening rush trains are operated out of Van Buren street and through the yards on less than two-minute headway, the average for the full period of service from 3:30 a. m. to 12:45 a. m., being a train every 7.5 min. The Illinois Central made a special effort to serve the public during the strike on the Chicago surface lines from September 1 to 6, 1922, during which period a record traffic of 157,517 passengers was handled in a single day. So many of these people have continued to use the Illinois Central that it has been necessary to add 10 trains to handle the business to the best advantage. The schedule at this time calls for 370 trains each week-day with six or seven coaches in a train during the rush hours, and shorter trains at other times throughout the day. The loading and unloading of passengers is expedited considerably by elevating the station platforms at all suburban tracks level with the car platforms.

One factor that has contributed to the success of the Illinois Central suburban service is the separation of the express and local runs between Van Buren street and Hyde Park (Fifty-third street). The express trains make this run of 5.5 miles in 11 minutes while the local trains, making more intermediate stops, require from 18 to 23 min. The express trains to South Chicago make eight stops, covering the run of 13 miles in a minimum of 35 min. The minimum running time to Matteson, a distance of 29 miles, including eight stops is 59 min.; and to Blue Island, 18.5 miles, including eight stops, the minimum running time is 45 min.

These schedules can be shortened by a higher acceleration rate, with the same running speed. A detailed study of the speeds of over 800 trains showed that 50 m.p.h. was the approximate maximum speed of the present steam equipment. While higher speeds were contemplated at first on the new work, estimates showed that added investment in equipment and the greater operating cost that would be required were out of proportion to the benefits derived. It was decided, therefore, to fix the balanced speed of the new electric equipment at 50 m.p.h. and provide an acceleration under load of 1.5 m.p.h. per sec. and a braking rate of 1.75 m.p.h. per sec. In other words, while the new equipment may not have a greater maximum speed than some of the present steam trains, it will start so much quicker that the trains will make the runs in considerably less time.

Switching Area Important Consideration

The electrification will include the extensive freight house and track layout just south of the Chicago river and extending south to East Roosevelt Road, which, including the additional electrified tracks just south of East Roosevelt Road, aggregates 40 miles of tracks, most of which are yard tracks. The switching service on all of the industry tracks in the terminal within the city limits will also be handled electrically.

Part of the Fordham yard at Burnside and part of the Wildwood yard south of Kensington are to be included in the electrification. At Markham yard (the general classification yard which is not yet completed) all of the southbound receiving yard as well as enough of the northbound departure yard will be electrified to permit the picking up of northbound trains. Inspection facilities for electric locomotives will be located at Markham yard and also at a point in the neighborhood of Twenty-sixth street.

The ordinance concerning the project provides that nothing in the terms shall prevent other roads not electrically operated from entering the tracks of the Illinois Central south of East Roosevelt Road with steam locomotives for the purpose of interchange, or to prevent the Illinois Central from using steam locomotives for the similar interchange of business to and from other lines not electrified until such time as these roads are required to electrify.

Freight Yard North of Randolph Street

The extensive track layout between Randolph street and the Chicago river is located close to the great loop district of Chicago. Freight houses of the Illinois Central, the Michigan Central and the Cleveland, Cincinnati, Chicago & St. Louis are located in this area. Large coal yards and warehouses of private concerns are also served in this yard. The short haul of coal, fruit, and general merchandise from this yard to the main wholesale and retail districts offers a decided advantage. Ground in this territory is very valuable and as the present tracks and freight houses cover almost all of the Illinois Central property there is not much room for further development under steam operation. However, with the introduction of electric propulsion it will be possible to house over many of these tracks with vast freight houses, cold storage warehouses for fruit, etc.

Freight Train Movements

As soon as the Markham yard is completed the main line steam freight service will terminate at this point. Therefore, there will be many through transfer trains to be handled electrically between Markham yard and the Randolph street freight houses. Berry trains, banana specials, etc., will be handled through to Randolph street intact. As high as 500 cars for the Illinois Central and 200 cars for the Michigan Central have been handled into and out of Randolph street in one day.

Transfer trains will also be made up in Markham yard for delivery to other roads. In addition to the traffic of the Illinois Central that of the Michigan Central and the Big Four must be handled electrically over the terminal territory.

A large amount of track changes, depression and elevation are to be carried out before the actual construction of the electrification can be started. These consist principally of the depression of the tracks between Twenty-fifth street and Forty-fifth street and their elevation between Forty-fourth street and Fifty-first street. In the rearrangement of tracks some industry tracks will be located on the extreme west side of the right of way next to which all of the suburban tracks will be consolidated. The through pas-

senger tracks will be just east of the suburban tracks and the freight tracks on the east side of the right of way. At certain places industry tracks will be served from the east side also.

Electrification to Meet Traffic Requirements

A commission was appointed in December, 1920, to make a thorough investigation of the different systems of electrification available. Practically all of the installations in the United States to date have been made to meet special operating problems in tunnels or on grades. The New York Central tracks in New York were electrified primarily to eliminate the smoke in the Park Avenue tunnel and the electrification covers through and suburban passenger service. This is a low-voltage direct current system with a third rail. The Norfolk & Western 11,000-volt single-phase alternating current electrification is principally for heavy freight service over mountain grades; it uses overhead contact wire. The New York, New Haven & Hartford uses an 11,000-volt single-phase alternating current system and is the only example of an electrification which handles through freight, switching, through passenger and heavy suburban passenger service. However, this installation extends to New Haven, a distance of 72 miles. An overhead contact wire is used in this installation. The Chicago, Milwaukee & St. Paul installation is a 3,000-volt direct current system with an overhead contact and handles through passenger and freight, but does not have a dense traffic or suburban services.

Three possible schemes were eliminated early in the study. On account of the extensive yards involved, a search was made for some sort of a self-contained power unit. The storage battery locomotive had to be eliminated on account of the seemingly prohibitive operating charges. A locomotive embodying some form of the Diesel engine may be developed for freight and through passenger service but a unit of this sort has not yet been built to meet the requirements of the present project. Three-phase alternating current system, which requires a double overhead contact system, was eliminated from consideration on account of the complications in construction of the overhead system without any advantages over the single phase.

Complete estimates of first cost, maintenance and operation were then compiled for the four remaining systems (i.e.) (1) 750-volt direct current with third rail; (2) 1,500-volt direct current with overhead contact; (3) 3,000-volt direct current with overhead contact; and (4) 11,000-volt alternating direct current with overhead contact.

The 750-d.c. system was eliminated because of the extensive freight yard trackage involved where a third-rail was undesirable from a safety standpoint and also on account of the fact that this system would require a heavy and extensive overhead layout to provide continuous contact for switching locomotives on ladder tracks and in complicated yards. Considering the climatic conditions along the lake front it was also feared that snow would drift on the tracks in the depression to such an extent as to interfere with the operation of the third-rail. Moreover, the cost of the 750-volt system did not differ materially from that of some of the other systems considered.

The 3,000-volt d.c. system has not been thoroughly developed for multiple unit operation and its use on the multiple unit system required additional complications not met with in the other systems considered. In converting the high voltage alternating current from the generating station into direct current for a 3,000-volt d.c. system it would be necessary to use motor generators which are more expensive and less efficient than synchronous converters which may be used on a 1,500-volt system. Due also to other causes the first cost and annual cost estimates were higher on the 3,000-volt d.c. system.

The investigation, therefore, narrowed down to the 1,500-volt d.c. and the 11,000-volt single phase a.c. systems. Although satisfactory means of eliminating the inductive interference of an a.c. system with the telegraph and telephone circuits have been devised it was the opinion of the majority of the commission that the experimentation and the expense involved would be appreciable. At this point consideration was given to the fact that a growth of traffic in the terminal would require more rolling equipment rather than more track mileage and that there was no immediate prospect of the system being extended to adjacent main line divisions. With this idea in mind it was considered that 1,500-volt d.c. equipment, with its lower first cost, was better adapted to the future development of this particular project. In the final analysis between the 11,000-volt a.c. single phase and the 1,500-d.c. systems it was decided to adopt the latter.

Suburban Equipment

The electrified suburban trains are to be made up of new all-steel coaches equipped with motors and connections for multiple unit control. Controllers will be located at each end of every car, thus eliminating the switching or turning of any equipment at terminals. None of the old coaches now in service are to be used.

In October, 1921, the Illinois Central placed in service 20 new all-steel suburban coaches which are now operated with steam but in which provisions were made for the electrical equipment to be installed later. These new cars have a seating capacity of 84 persons. Therefore, better service can be given with fewer cars than are now used as the old coaches seat only 56 to 65 persons. These new cars were described in detail in the *Railway Electrical Engineer* for December, 1921. The 220 additional suburban coaches required for the new project will be designed along similar lines.

Eighty to 100-ton switching locomotives will be used in the various yards. On the through transfer between Randolph street and Markham yard it is the intention to use two locomotive units coupled. In this service under rated capacity the locomotives will operate at approximately 20 m.p.h.

The Illinois Central, as the owner of its own coal field and an advantageous power house site on the Calumet river near Riverdale, is peculiarly well fitted to build and operate its own power generation station. However, no decision has yet been reached on this point and the power may be purchased from a public utility company.

With the electrification the automatic signaling will be entirely rebuilt as a complete alternating current system. The existing direct current track circuits will be replaced with alternating current apparatus. Impedance bonds will be required at the ends of all circuits to isolate the track sections for the a.c. signaling current and to provide a continuation of the return propulsion circuit. The enclosed disc type of signals now used will be replaced with three-color type light signals. Although some of these signals have already been replaced, the new program calls

for an entirely new relocation of the greater part of the signals.

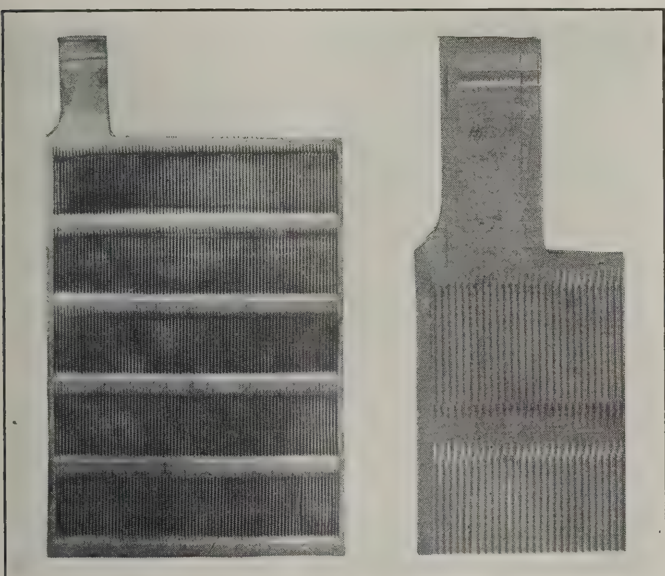
Engineering Organization

In conducting the investigation the late A. S. Baldwin, vice-president of the company, was chairman of the commission. With him was associated D. J. Brumley, chief engineer of the Chicago terminal. In the course of their investigations Mr. Baldwin and Hugh Pattison, electrical engineer for the commission, toured Italy, Switzerland, France and England to investigate electrification. It was upon his return to this country that Mr. Baldwin died. Mr. Brumley succeeded him as chairman of the commission, which included Bion J. Arnold of Chicago, George Gibbs and Cary T. Hutchinson, New York, consulting engineers, and W. M. Vandersluis, engineer-secretary. Having rendered the report covering the decision on the fundamental features of the electrification the function of the commission is now terminated.

The New Putnam Train Lighting Storage Battery

Unique Plate Structure, Accessible Filler Openings and Non-Corrosive Terminals are Features

A NEW type of lead storage battery has been devised by the Safety Car Heating & Lighting Company, and is now being manufactured at New Haven, Conn., for train lighting purposes. Excepting such sets as are provided with a special filling arrangement for flushing the cells without removing the crates from their positions in the battery compartment under the car, the general appearance of the battery is similar to other types of lead batteries for car lighting service with two cells in a crate.



(a) (b)

Fig. 1—(a) One of the Leaves or Units Which Make Up An Element (b) An Enlarged Section of One of the Leaves Showing the Wire Construction

Plate Construction

Probably the most unique feature of the battery is the plate construction. Both the positive and negative elements are made of several leaves, one of which is shown in Fig. 1a, with an enlarged view, Fig. 1b. Each leaf is made from a sheet of chemically pure lead milled so that it consists of several groups of parallel cylindrical rods or wires held at intervals by rectangular cross members.

There are six of the leaves used to make one positive element while eight are used to make an inside negative element and five for each of the two outside negative elements. The four outer edges of the leaves making the negative group are burned together before the element is connected to the strap. In the case of the positive element, however, the leaves are attached to a lead bar and burned together along the upper edge only so that each leaf is free to expand or grow both laterally and vertically. Instead of using separators each positive element is placed in a reinforced rubber envelope as shown in Fig. 2. The envelope also acts as a suspension for the element. It is made larger than the plate to allow for the normal growth of the latter during formation. Both elements are of the Plante type.

It is claimed by the manufacturers that the cylindrical rod construction eliminates entirely the tendency of active material to separate from the base lead, buckling of plates is eliminated and the largest possible amount of reserve lead is retained after the original formation, with a minimum total weight of plate.

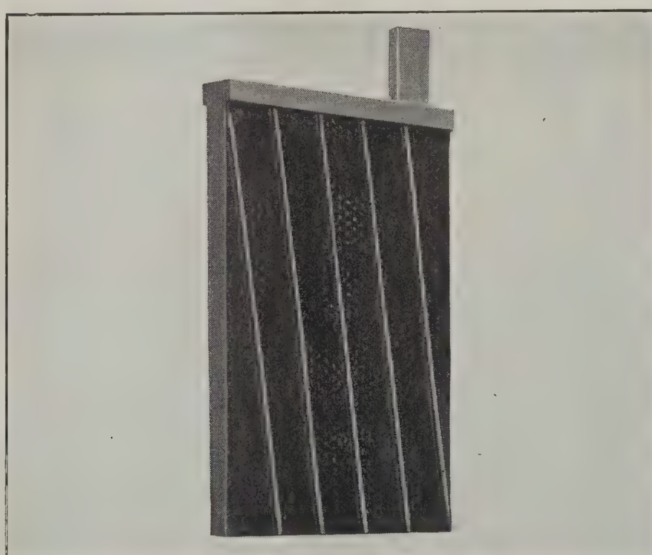


Fig. 2—A Positive Element Complete in Its Reinforced Rubber Container

Assembly

The "Putnam" battery, as it is called, is assembled in two-cell units and can be supplied either with or without the special filling device as shown in Fig. 3. Either rubber jars or lead tanks are used as containers for the plate groups and the two containers in turn are placed in a solid wooden battery box. Lead-Antimony

covers are used for both rubber and lead jars. When provided with the special filling device, only a small vent hole is left in the cover as the battery cells are flushed through the two filler openings shown at the left, Fig. 3. Each filler opening is covered by a threaded hard rubber plug and is connected to a tank or jar

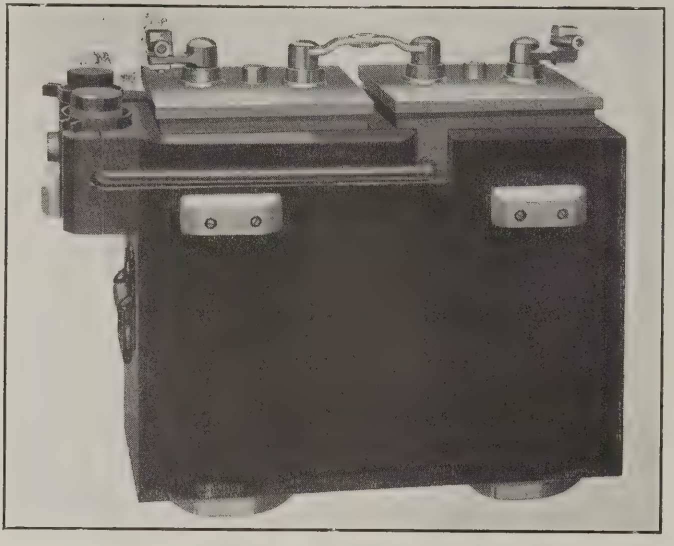


Fig. 3—A Two-Cell, 300 Ampere-Hour Unit With Front Filler Openings

through a piece of lead tubing. As both openings are mounted on the front of the battery box, the splashing or spilling of acid over the tops of the batteries, when flushing or taking hydrometer readings, is minimized. The small opening or vent for the escape of gas in the cell covers is one inch higher than the filler openings in front, thus making it practically impossible to flood the

Fig. 4—New Manufacturing Facilities for the Safety Company at New Haven, Conn. The Building on the Left and the Addition to the Building on the Right Will Constitute the Putnam Battery Plant

cell when filling. As stated before, it is not necessary to pull the crates out of the battery compartment under the car for filling when they are equipped with this special front-fill arrangement.

Connections

The risers from the groups are cylindrical and are fitted in the covers through soft rubber bushings. Terminals, as shown in Fig. 3, are burned on to the risers. These are burned on at the top only so that when a flame is applied to the top of the terminal it can be pulled off.

The bolts and nuts used for making the connections to the terminals are of a special alloy. This alloy, in appearance, is similar to lead, but is much harder. It has such properties that it will take a good thread on which the nut will not bind, it has about half the tensile strength of brass and is non-corrosive. An amalgamated washer is used between battery terminal and the connector terminal. This washer prevents a film of insulating sulphate being formed at the connections. Such a film will cause the introduction of considerable resistance in the battery circuit. The type of battery shown in the illustration has 11 plates and a capacity of about 285 empere hours. Other sizes and capacities are being manufactured.

Extensive additions are being made to the plant of the Safety Company at New Haven, Conn., to permit production of these batteries.

Pennsylvania Improvements Include Electrification of Altoona Grade

The Pennsylvania system has announced the program for extensive improvements to be made at Altoona, Pa., including the construction of two extremely large repair shops and the electrification of the heavy grades west of Altoona. The first of the improvements will be made at Juniata shops and includes the building of a new erecting and machine shop, 340 ft. by 670 ft., including a midway crane runway with a 105 ft. span and 715 ft. long. This large shop will be devoted to repairing and building locomotives, and will accommodate 49 locomotives at one time. The framework will be of steel and the walls of brick. The locomotives erecting bays will have two 250-ton capacity electric traveling cranes for lifting locomotives, and six 15-ton capacity cranes for lighter work. The machine bays will have two 25-ton capacity cranes, together with jib cranes of from 1 to 8 tons' capacity.

There will also be erected a reinforced concrete storehouse, three stories high, with basement, which building is to be 60 ft. by 400 ft. A crane runway for handling material will also be erected with a 95-ft. span and about 600 ft. long.

The building of the shop and storehouse will necessitate changes in the existing buildings as follows: the scale shop will be moved to a new location and will be changed to a flue shop, the machinery now in the scale shop being transferred to the present paint shop. The present storehouse building will be moved to a new location and will be used as a cab shop. The present erecting shop will be changed to a paint shop, while machinery will be installed in the present paint shop and the name changed to Machine Shop No. 2.

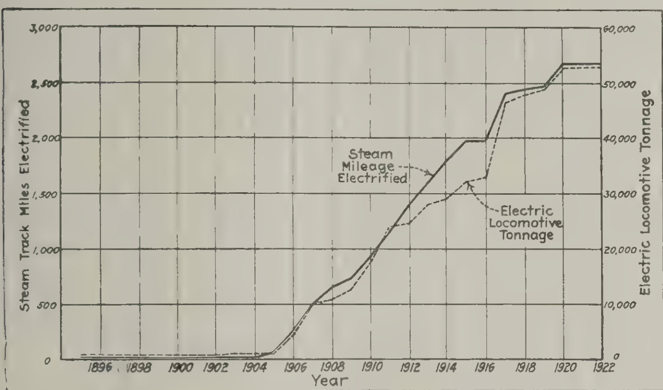
At the Altoona car shops will be located facilities for preparing repaired locomotives for service. The present circular building, known as the freight car shop, will be remodelled and 15 stalls will be used as a finishing shop. East of this shop will be located the necessary ash pits and coal handling facilities.

Further additions to the shops at Altoona will be made following the electrification of the heavy grade west of the city. After the electrification is completed, the roundhouse at Sixteenth street, Altoona, will be abandoned.

A. E. R. A. Committee Reports on Electric Traction

Data and Curves Show Important Features of Railroad Electrifications in this Country and Abroad

THE Heavy Electric Traction Committee of the American Electric Railway Engineering Association, which presented its report in the early part of October at the annual convention of the Association in Chicago, has been working in co-operation with similar committees of other associations to further the interests of heavy electric traction and to render more efficient committee work of this kind. As a part of its duties this committee has to revise and keep up to date a chart showing the electrified mileage and tonnage of electric locomotives of the United States. The committee also revises and keeps up to date a bibliography on heavy electric traction.



Growth of Steam Railroad Mileage Electrified and Electric Locomotive Tonnage in Heavy Traction Service in the United States and Canada

The question of general co-operation in the study of heavy electric traction has been taken up with the various technical organizations which are actively interested in the several aspects of electrification. The committee did not have in mind any premature attempt at standardization or discussion of questions which might embarrass the managements of electrified railroads or of railroads contemplating electrification, but did suggest a central organization to co-ordinate the work of studying electrification problems and of collecting information, in order to avoid duplication of effort.

While many of the organizations with whom the matter was taken up expressed interest in the proposal, and while all agreed in the value of co-operation, it seems evident that if such a movement is to be successful it should be under the leadership of the steam railroads.

It is not improbable that the steam railroads will before long see the necessity for a joint committee on electrification. If this is the case, the desirability will undoubtedly soon be felt of calling upon all associations and organizations having technical knowledge of value. In the meanwhile, there appears to be nothing further that the committee can accomplish in this direction.

The chart showing electrified mileage and tonnage of electric locomotives in the United States has been brought up to date and is again presented. It will be noted that practically no additions have been made during the past year. Many railroads, however, are actively considering the problem of electrifying and it is probable that during the coming year there will be important decisions in connection with electrification, and considerable work will probably soon be started.

Foreign developments in electrification are of especial interest at the present time. Little comprehensive information on this subject, however, is now available, and the committee has prepared in a preliminary way a list of elec-

ELECTRIC OPERATING DATA OF THE PRINCIPAL AMERICAN RAILROADS

Name of Road	Mileage of road	Mileage of single track	Total Kw-hr. per year	Number of locomotives			Aggregate wt. of locos. pass. frt. switch.	Multiple unit cars		Gross ton miles per year (trailing)		Locomotive miles per year	
				Pass.	Frt.	Switch.		No.	Av. wt.	Passenger	Freight	Passenger	Freight
							Tons		Tons				
Baltimore & Ohio R. R.	3.6	7.96	5,628,690	4	4	0	720	0	...	...	...	†232,786	
Boston & Maine R. R.	7.92	23.80	7,250,640	†7	...	...	916	0	...	18,424,000	158,053,000	36,440	113,502
Butte, Anaconda & Pacific	28.00	90.50	18,749,189	2	26	...	2,240	0	...	13,879,260	200,149,124	83,524	609,280
Chicago, Milwaukee & St. Paul	646.70	860.40	¶160,932,232	15	42	5	16,519	0	...	599,516,000	2,901,500,000	920,568	1,900,564
Erie R. R.	34.00	40.00	2,042,843	...	...	...	...	8	52	24,641,408	...	...	...
Grand Trunk Ry.	4.00	12.00	4,103,476	†6	...	...	796	0	...	4,280,156	35,507,215	10,746	180,594
Great Northern R. R.	4.70	6.50	3,003,700	†4	...	...	460	0	...	3,800,000	8,411,067	26,424	46,320
Long Island R. R.	*85.69	227.08	105,450,000	0	1	0	90	634	46	1,073,388,277	...	...	27,499
Michigan Central R. R.	4.60	26.40	8,246,560	†10	...	...	1,080	0	...	14,067,000	60,408,000	48,525	243,907
New York Central	53.60	261.80	...	73	...	...	8,669	256	57	1,216,756,000	3,991,000	1,306,417	893,511
New-York, New Haven & Hartford	*87.86	530.58	‡130,059,200	52	38	16	11,652	79	63	‡1,254,678,065	1,123,694,301	‡3,531,068	894,734
New York, West. & Boston	23.22	73.41	11,422,794	...	...	1	80	45	60	97,917,960	...	...	11,274
Norfolk & Western	35.38	108.26	50,503,450	0	12	0	3,600	0	...	...	...	21,138	330,536
Pennsylvania R. R.:													
New York Terminal	13.41	100.18	59,749,184	33	...	1	5,281	8	55	§595,438,539	...	1,462,994	592,496
West Jersey & Seashore	75.00	150.38	18,339,689	...	...	...	...	107	46	261,496,377	...	...	...
Paoli & Chestnut Hill	30.00	117.40	23,653,205	...	1	...	258	115	59	171,835,943	...	...	...
Southern Pacific R. R.													
O. A. & B. Line	118.00	101.20	...	...	...	...	...	121	55	225,635,500	...	...	...
Portland Line	146.32	141.70	...	...	...	...	...	49	51	100,148,000	...	...	...

* Not including trackage rights into New York.
† Total passenger and freight.
‡ Includes D. C. zone.
§ Includes weight of locomotive.
¶ Partial electric operation on part of zone.

LIST OF FOREIGN ELECTRIFIED RAILROADS

Railroad	Termini	Route, miles	System of electrification	No. of locomotives	No. of motor cars	No. of trailer cars	Date installed
ENGLAND							
Midland Ry.	Lancaster–Heysham–Morecambe	9.7	A.C.—1 ϕ — 25~ — 6,600 v.—Catenary.	......	3	6	1 90
London, Brighton and South Coast Ry.	Victoria–London Bridge	8.7	A.C.—1 ϕ — 25~ — 6,600 v.—Catenary.	......	50	82	1909
	Battersea Park and Peckham Rye to Crystal Palace	13.6	A.C.—1 ϕ — 25~ — 6,600 v.—Catenary.	......			1911
Lancashire and Yorkshire Ry.	Liverpool (Exchange Sta.) to Crossens.		D.C.— 600 v.— 3d rail (4th rail return).	......			1904
	Liverpool (Dingle) to Crossens via Liverpool.		" " " "	......			1906
	Seaforth and Bankhall to Aintree	37.25	" " " "	......	70	84	1906
	Aintree to Maghull		" " " "	......			1906
	Maghull to Town Green		" " " "	......			1911
	Town Green to Armskirk		" " " "	......			1913
	Manchester–Burg	8.1	D.C.— 1,200 v.— 3d rail	......	......	......	1916
North Eastern Ry.	Newcastle-on-Tyne–Benton–Tynemouth.	29.5	D.C.— 600 v.— 3d rail	2 (frt.)	65	44	1904
	Shildon–Newport	18.0	D.C.— 1,500 v.— Catenary	10	......	......	1916
Great Western Ry.	Bishops Road–Westboune Park	4.1	D.C.— 600 v.— 3d rail (4th rail return).	......	40	80	1906
Metropolitan Ry.	London and Suburban points	......	D.C.— 600 v.— 3d rail (4th rail return).	......	20	......	1903
AUSTRALIA							
Victorian Rys.	Melbourne–Suburban points	143	D. C.—1,500 v.—Catenary	......	400	400	1919
AUSTRIA							
Ueberetsch Ry.	Bozen–Mendelridge	10.7	D.C.—1,200 v.—Catenary	......	4	......	1910
Vienna–Pressburg Ry.	Vienna–Pressburg	43.4	D.C.—500 v.—3d rail and catenary and A.C.—1 ϕ—15,000 v. catenary.	6 D.C. 8 A.C.	10 D.C.	24 A.C.	1911
Mittenwald Ry.	Innsbruck–Scharnitz; Garmisch–Partenkirchey; Griessen–Reutte	66.5	A.C.—1 ϕ — 15~ — 15,000 v.—Catenary.	9	......	......	1912
Austrian State Rys.	St. Pölten–Mariazell–Gusswerk	57.0	A.C.—1 ϕ — 25~ — 6,500 v.—Catenary.	19	......	......	1910
BRAZIL							
Paulista Ry.	Jundiahy–Campinas	28	D.C.—3,000 v.— Catenary	16	......	......	1921
CHILE							
Chile State Rys.	Valparaiso–Santiago–Los Andes	144	D.C.—3,000 v.— Catenary	39	......	......	Under construction
Bethlehem Chile Iron Mines Co.	Tofo–Cruz–Grande	15	D.C.—2,400 v.— Catenary	3	......	......	1920
ARGENTINE							
Central Argentina Ry.	Retiro–Tigre	50	D.C. — 800 v.— 3d rail	......	67	50	....
FRANCE							
Orleans Co.	Paris (Quai d'Orsay to Austerlitz)	2.5	D.C.— 600 v.— 3d rail	18	7	......	1900
Orleans Co.	Paris (Austerlitz) to Jurisy	11.9	D.C.— 600 v.— 3d rail				1904
Ouest Co. ((State repurchased in 1908).	Invalides Sta. Paris–Versailles	11.2	D.C.— 600 v.— 3d rail	......	44	......	1901
Paris–Lyons–Mediterranean	Cannes–Grasse	.....	A.C.—1 ϕ — 12,000 v.— 25~.	1	......	......	1911
Midi Co.	Montagne de Villefranche–Perpignan.	29.0	A.C.—1 ϕ — 16⅔~ — 12,000 v. Catenary.	......	......	......	1911–13
	Pau–Pierrefitte–Tarbes	36.6	" " " "				
	Tarbes Bagneres de Bigorre, Arreau, Bagneres de Luchon.	125.9	" " " "	......	......	......	
French State Ry.	St. Georges de Commiers–La Muve.	19.3	D.C.— 2,400 v.— Catenary	......	......	......	1904
GERMANY							
Prussian State Ry.	Dessau–Bitterfeld	16	A.C.—1 ϕ — 15~ — 10,000 v.—Catenary.	11	......	......	1911
	Halle–Leipzig–Bitterfeld; Dessau–Magdeburg. (Continuation of Dessau–Bitterfeld line).	95	" " " "	......	......	......	....
(Silesia)	Lauban–Königszett and Branches	170	A.C.—1 ϕ — 16⅔~ — 15,000 v. — Catenary.	25	......	......	1914
Mittenwald Ry.	(See Austria.)						
Wiesemthal Ry.	Basel–Schopfheim–Säckingen–Zell.	31	A.C.—1 ϕ — 15~ — 10,000 v. — Catenary.	13	......	......	1912
HOLLAND							
Netherland Railways	Rotterdam–the–Hague–Scheveningen.	21.7	A.C.—1 ϕ — 25~ — 10,000 v.—Catenary.	......	78	17	1908
NORWAY							
Thamshavn–Lökken Ry.	Thamshavn–Svorkmo–Lökken	......	A.C.—1 ϕ — 25~ — 6,600 v.—Catenary.	8	1	......	1908
Norwegian State Rys.: Rjukanbanen Line	Notbdden–Tinosset	19.0	A.C.—1 ϕ — 15~ — 10,000 v.—Catenary.				
" "	Sagheim–Vestfjorddalen *	19.6	" " " "	5	......	......	1911–12
	Kristinia–Drammen	......	" " 16,000 v. — Catenary	†24	......	......	Under construction
	Riksgransen–Narvik	......	" " —25~ "	†11	......	......	"
SPAIN							
Southern Ry. of Spain	Gergal–Sante Fe	14	A.C.—3 ϕ — 25~ — 5,200 v.	5	......	......	1911
Northern Ry. of Spain	Budonzo–Ujo (Pajaves Grade)	40	D.C.—3,000 v.	12	......	......	Under construction
Pamplona–Sanguesa Ry.	Pamplona–Aoiz–Sanguesa	39±	A.C.—1 ϕ — 25~ — 6,600 & 600 v.— Catenary.	......	......	......	....

LIST OF FOREIGN ELECTRIFIED RAILROADS — (Continued)

Railroad	Termini	Route, miles	System of electrification	No. of loco-motives	No. of motor cars	No. of trailer cars	Date installed
			ITALY				
Italian State Rys.	Milan Varese–Porto Ceresio	45.2	D.C.—650 v.—3d rail	......	......	......	1901
	Valtellina Lines						
	Lecco–Colico–Sondrio	49.3	A.C.—3 ϕ —15 to 16~—3,400 v.—Catenary.	15	......	......	1901
	Colico–Chiavenna	16.3	" " " "				1901
	Monza–Lecco	23.2	" " " "				1901
	Turin–Bussolena–Modane	64.9	A.C.—3 ϕ —16 to 17~—3,700 v.—Catenary.	......	......	......	1919
	Bussoleno–Susa	4.7	" " " "	......	......	......	1919
	Turin–Pinerolo	23.0	" " " "	......	......	......	1917
Italian State Rys.	Savona–San Giuseppe–Ceva	28.9	" " " "	......	......	......	......
	Savona–Sampierdarena	24.8	" " " "	......	......	......	1916
	Giovi Lines						
	Ronco – Busalla – Sampierdarena.	16.9	" " " "				1916
				40	......	......	1910
	Ronco – Mignanego – Sampierdarena–Genoa.	19.7	" " " "				1914
	Genoa–Pisa	......	......	......	......	......	Under construction.
	Bologno–Pistoia–Florence	......	......	......	......	......	"
	Bologno–Foenza–Florence	......	......	......	......	......	"
	Pinerolo–Torre Pellice	......	......	......	......	......	"
	Bricherasio–Barge	......	......	......	......	......	"
	Rome–Tivoli	......	......	......	......	......	"
	Rome–Carano–Nettuno	......	......	......	......	......	"
	Voghera–Alessandria	......	......	......	......	......	"
	Tortona–Nova	......	......	......	......	......	"
	Tortona–Arquata	......	......	......	......	......	"
Ferrovia–Biella Co. Limited	Santhia–Biella	18.6	D.C.—4,000 v.—Catenary	......	......	......	......
Ferrovie–Torino–Cirie–Lanzo Co. Limited.	Turino–Lanzo	13.4	" " "	......	......	......	1921
Valle Brembana Electric Railway Co. Limited.	Bergamo–San Giovanni in Bianco	18.8	A.C.—1 ϕ —25~—6,000 v.—Catenary.	......	......	......	......
Mediterranean Ry. Co	Terni–Umbertide	66.9	A.C.—1 ϕ —25~—11,000 v.—Catenary.	......	......	......	......
	Ponte San–Giovanni–Perugio	3.3	" " " "	......	......	......	......
			SWEDEN				
Swedish State Ry.	Kiruna–Riksgränsen	81	A.C.—1 ϕ —25~—16,000 v.—Catenary.	22	......	......	1914
	Kiruna–Gallivare	156	" " " "	......	......	......	1920
	Gallivare–Ripats		" " " "	......	......	......	1921
	Nattavaara–Svartön	......	" " " "	‡12	‡2	......	Under construction
	Riksgränsen–Narrik (Norway)	......	" " " "	‡10	......	......	"
	Stockholm–Goteborg	......	......	......	......	......	"
Roslags Ry.	Stockholm–Djursholm	......	......	......	......	......	1893
Hälsingborg – Rää – Ramlösa Ry.	......	......	......	......	......	......	1906
Mellersta Oestergötland's Ry.	Borensberg–Klockrike	......	......	......	......	......	1908
	Linköping–Fagelsta	......	......	......	......	......	1915
	Fornasa Motala	......	......	......	......	......	1915
Stockholm–Saltsjöbaden Ry.	......	......	......	......	......	......	1913
Lund–Bjärred Ry.	......	......	......	......	......	......	1916
Klarälv Rys.	Karlstad – Munkfors – Hagfors – Filipstad.	......	......	......	......	......	Under construction
			SWITZERLAND				
Bernese Alps Ry.	Spiez–Frutigen	8.7	A.C.—1 ϕ — $16\frac{2}{3}$~ — 15,000 v. — Catenary.				1910
(Berne–Loetschberg–Simplon.)	Frutigen–Brieg	37.3	" " " "				1913
	Spiez–Scherzligen	6.2	" " " "				1915
	Spiez–Interlaken–Boenigen	12.4	" " " "	28	3	......	1920
	Spiez–Erlenbach–Zweisimmen	21.7	" " " "				1920
	Thun–Belp–Berne	21.1	" " " "				1920
	Berne–Schwarzenburg	13.0	" " " "				1920
Rhaetian Railways	Schols–Bevers						
	St. Moritz–Samaden–Pontresina.	38.5	A.C.—1 ϕ — $16\frac{2}{3}$~ — 11,000 v. — Catenary.				1913
	Bevers–Thusis						1919
	Filisur–Davos	47.2	" " " "				
	Thusis–Languart			21	......	......	
	Davos–Klosters	34.8	" " " "				1921
	Klosters–Landquart						
	Reichenau–Dissentis	51.6	......	Electrification under construction.			
Swiss Federal Rys.	Scherzligen–Thun	.6	A.C.—1 ϕ — $16\frac{2}{3}$~ — 15,000 v. — Caternary.	4	......	......	1918
	Berne–Thun	19.3	" " " "				1919
	Erstfeld–Biasca	55.9	" " " "	59	......	......	1920
	Biasca–Chiasso	46.6	" " " "				
	Immensee–Rothkreuz	4.3	" " " "				
	Erstfeld–Lucerne	37.3	" " " "	10	Electrification under construct'n		
	Goldau–Zurich	27.8	" " " "				
	Lucerne–Zug	17.4	" " " "				
	Sion–Lausanne	57.2	" " " "	11	"	"	
Burgdorf Thun Ry.	Burgdorf–Thun–Langnau	34.8	A.C.—3 ϕ — 40~ — 750 v.—Catenary.	5	6	14	1899
Simplon Tunnel Ry.	Sion–Brieg–Iselle	47.2	A.C. 3 ϕ — $16\frac{2}{3}$~ — 3,000 v.—Catenary.	4	......	......	1905
Rhatische Ry.	St. Moritz–Schuls	.....	A.C.—1 ϕ 10,000 v.—Catenary	14	......	......	1913
	Samaden–Pontresina						
Fribourg–Morat–Anet Ry.	Fribourg–Morat–Anet (Ins.)	20.5	D.C.—840 v.—3d rail	......	......	......	1903

* This section of line owned by Norsk Hydro.
† To be delivered in 1921.
‡ To be delivered in 1922.

trified railroads abroad, which indicates roughly the territory which is electrically operated. The accompanying table has been made as complete as possible, but it is not unlikely that there may be some errors or omissions. It is certain that on account of the present activity abroad it will be necessary to add considerable data within a few months, and it is suggested that the table be continued from year to year and that the information be thus kept up to date. It is probable that the information can also be satisfactorily indicated on maps, and it is suggested that consideration be given, possibly next year, to thus supplementing the list by a graphic presentation which would show at a glance the location of electrified territory.

The committee presents tabulated statistics of some of the principal electrified railroads in this country. Where information has not been otherwise available, data has been taken from a report of George Gibbs, presented at the International Railway Congress this year. It is merely an outline but indicates in a general way some characteristics of electrical operation by railroads in this country.

A supplement to the bibliography published last year is presented, which thus brings the bibliography up to date as of July 1, 1922. It is suggested that the main bibliography be revised and corrected and brought up to date, and at a favorable opportunity, issued as a separate publication, for sale at a nominal price. It is felt there is a distinct need for a work of this sort, and that this need will be an ever-increasing one, with the continuing growth of railroad electrification.

The report is signed by Sidney Withington, Chairman, N. Y., N. H. & H.; C. H. Quereau, New York Central; J. H. Davis, B. & O.; H. W. Cope, Westinghouse Electric & Mfg. Co.; J. C. Davidson, N. & W.; J. V. B. Duer, Penn. R. R.; L. S. Wells, Long Island Railroad; R. Beeukes, C., M. & St. P., and A. H. Armstrong, General Electric Co.

Long Island to Improve and Extend Electric Service

To care for present requirements and to prepare for the carrying out of a plan for improving and extending the electric service on the Long Island, a 25,000-kilowatt generator is now being installed in the Long Island City power plant and additional feeders are being run in conduit along the right of way to Forest Hills.

This fall the company will begin the extension of the elevated structure through Hollis, eastward through Queens to the Nassau County boundary line, a distance of about two miles. This section will be elevated and four-tracked at the same time and the four-track section will be continued to Floral Park, two miles farther east. It is estimated that the work will require about a year and a half for completion at a cost of approximately $2,000,000. Building of many new homes in Hollis, Queens, Bellrose and Floral Park has caused a large increase in traffic with resultant congestion. The new four-track elevated structure will make it possible for express trains to pass locals between Hollis and Queens and thus speed up operation over the entire line.

Tentative plans for future building include extending the electrification of the Montauk division from Lynbrook to Babylon, a distance of 19 miles, the entire Oyster Bay branch and the Wading river branch to

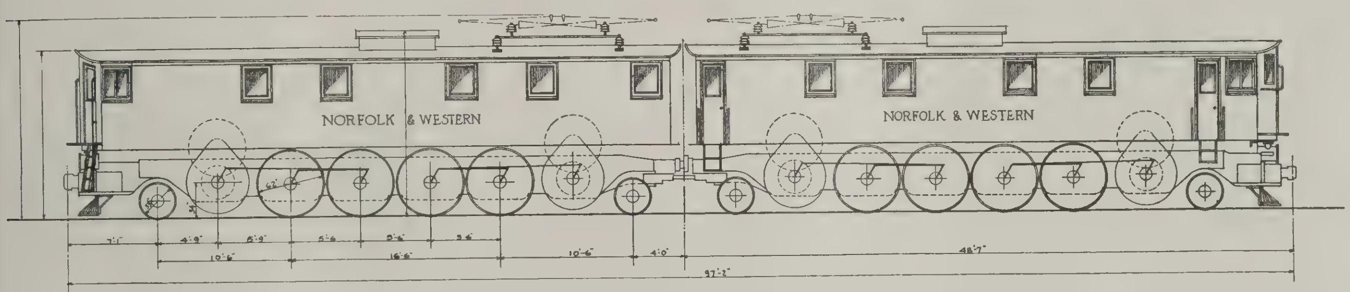
Western Lines of the Long Island

Northport. It is also planned to connect the old unused Central Railroad line with the main line to divert express service from the entire Montauk division east of Babylon through Hicksville and Mineola to Jamaica.

The Long Island is properly a standard railroad and it is the contention of its president, Ralph Peters, that New York City should not depend on the Long Island to furnish rapid transit, as this transportation line is needed to serve all other parts of Long Island for passenger and freight transportation. In explaining the situation President Peters said: "I have tried to impress upon the transit commissioners of this city that they ought to build a four-track rapid transit line from Jamaica over the Queens Boulevard route to Long Island City, thence under the river and across the city to 10th Ave., intersecting all the north and south lines on Manhattan Island and giving the Borough of Queens real rapid transit."

New Electric Locomotives for the Norfolk & Western

As noted in the September issue of the *Railway Electrical Engineer,* the Norfolk & Western has placed an order for four electric locomotives for use on its mountain division known as the Elkhorn Grade. The new locomotives will be of the same general type as those which have been in use since the commencement of electric operation; namely, the split-phase, which operate from a high-tension single-phase a. c. trolley and are provided with a static transformer and rotary phase-converter for supplying low voltage three-phase power to the induction type traction motors. Each locomotive will consist of two units coupled together by a short rigid bar or link. The wheel arrangement is 2-8-2 + 2-8-2. The pony trucks on each unit will be equalized with the drivers, the whole arrangement of wheels and spring suspension being similar to a Mikado type steam locomotive. There will be four motors geared to jackshafts, connected in turn to driving wheels by side rods, two single motors being provided per unit (one per jackshaft). This arrangement is different from the present locomotives, which are 2-4-4-2 + 2-4-4-2 and have two twin motors per cab.



Preliminary Drawing of Double Unit Locomotive Showing Wheel Arrangement and Location of Traction Motors

The motors and jackshafts will be located between the pony truck wheels and the driving wheels, the main motor rods being connected to the second pair of drivers, the first and second pair of drivers being coupled.

The cab of each unit will be rigidly secured to the main engine frames, and the main apparatus, such as motors, phase-converter, transformer, etc., supported directly on the engine frames and cross-tie castings.

The motors are rated at 1,000 hp. each, and have a pinion at each end of the rotor shaft with collectors outside of the pinions. The locomotives will have about 30 per cent greater capacity than the present locomotives.

Principal Characteristics.

Weight on drivers	560,000 lb.
Total weight approximately	380 tons
Tractive effort, continuous at 14 M. P. H.	90,000 lb.
Tractive effort, one hour at 14 M. P. H.	168,000 lb.
Tractive effort, starting	168,000 lb.
Horse power, continuous at 14 M. P. H.	3,330 hp.
Horse Power, one one at 14 M. P. H.	4,000 hp.
Speeds, 14 and 28 M. P. H.	

The order for the electrical equipment has been placed with the Westinghouse Electric & Manufacturing Company and for the mechanical parts with the American Locomotive Company.

Radio Experiments on the Frisco

Successful tests of wireless telephony from and to moving trains, operating between Oklahoma City, Okla., and Lawton, a distance of 90 miles, were carried out a short time ago. A baggage car was equipped with an antenna and wireless equipment was installed in the car. The antenna was of the cage type, made up of four units, each containing four wires and supported on ¾-in. pipe, approximately 18 in. above the ventilator run on the roof of the car. The wireless equipment consisted of a single circuit Clapp-Eastman receiving set with two stages of amplification, and a Magnavox loud-speaker, with two additional stages of amplification. There was also a small wireless telegraph transmitting set of the spark type.

Communication was maintained with Oklahoma City until reaching Chickasha, a distance of 40 miles. About that time a severe electrical storm was encountered and Oklahoma City was cut out. It developed later that lightning had struck the transformer at the Oklahoma City broadcasting station, which made it necessary for the station to close down. Telegraph signals continued from Ft. Sill, but static conditions were so bad that it was very difficult to read them. The government radio station at Ft. Sill stated that its station had been practically out of service all of the afternoon because of static conditions.

Returning to Oklahoma City the same night the car left there again in train No. 9 at 11:30 a. m., the following day. The atmospheric conditions had improved greatly and telephone communication was maintained with Oklahoma City all the time on the way to Lawton, 90 miles away. A return trip was made to Oklahoma City with equally good success with the apparatus.

General News Section

The Pennsylvania will build three electric locomotives in its Altoona Shops.

The Brown Instrument Company, Philadelphia, Pa., has opened a New England branch at 185 Devonshire Street, Boston, Mass., with George Goodman in charge.

The Baltimore & Ohio has ordered from the General Electric Company two 120-ton, 600-volt direct current electric locomotives to be delivered in March 1923. These locomotives will be practically duplicates of those now in use in the Detroit tunnel on the Michigan Central.

The "Pullman News," October issue, contains an announcement of the establishment of free industrial insurance by the Pullman Company in connection with its system of employee representation. Approximately 33,000 of Pullman employees, both men and women, are eligible to this protection.

The Hungarian government is making strenuous efforts to electrify the state railways through the agency of a special government commission. Trials are to be made of a single-phase direct-current locomotive to be built by the Hungarian State Machinery Factory in connection with the Ganz Electric Company of Budapest.

The Prest-O-Lite Co., Inc., New York, announces a new complete line of storage batteries for railway signaling and interlocking, conforming to signal section A.R.A. specifications. The railroad sales division of the National Carbon Company, Inc., Cleveland, O., has been appointed to handle the sales and field service of this new line of storage batteries.

The New York, New Haven & Hartford has ordered five 181-ton electric locomotives from the Westinghouse Electric & Manufacturing Company. These locomotives will practically duplicate the ones now in use for high-speed passenger service. They will be equipped for operation on either alternating or direct current, the direct current equipment being used to permit operation into the Grand Central Station, New York.

The Krantz Works of the Westinghouse Electric & Manufacturing Company have been moved to Mansfield, Ohio, from Brooklyn, N. Y., where they have been situated for a number of years. The transfer to Mansfield offers better facilities for increased production, gives the works location in the central part of the country with easy access to a large number of railroads and to both middle west and eastern offices of the Westinghouse Company.

The riding characteristics of one of the Baldwin-Westinghouse electric locomotives used on the Chicago, Milwaukee & St. Paul have been improved by dividing the cab in two parts, according to a report called the "Log of the Manhattan," issued by the Baldwin Locomotive Company, which describes a trip made through the West by President Vauclain and party. The report states: "Engines 10,306 and 10,307 took the curves easily and rode well. It is only in comparison with Engine 10,301 that they suffer, because Engine 10,301 seems to leave nothing to be desired." The last mentioned locomotive has a divided cab, while the other two have not.

The United States Civil Service Commission announces open competitive examinations for junior engineer, junior physicist and junior technologist on November 22, 1922. Vacancies in the Bureau of Standards, Department of Commerce, for duty in Washington, D. C., or elsewhere at $1,200 to $1,500 a year and in positions requiring similar qualifications, at these or higher or lower salaries will be filled from these examinations. Applicants should apply for form 1312, stating the title of the examination desired to the Civil Service Commission, Washington, D. C., or to the Secretary of the United States Civil Service Board.

Radio in Cars Without Outside Aerial

In experiments made on the "Broadway Limited" on October 12 the Pennsylvania Railroad demonstrated the practicability of radio telephone communication with moving trains without the aid of exterior wires. Speeches and music were successfully heard and results were pronounced highly satisfactory by Arno Zillger, Chief Engineer of the E-D Manufacturing Company of Philadelphia, who made the tests. A receiving set was used in a compartment of a steel sleeping car. The only aerial used in receiving signals was a four-strand loop around an eighteen-inch frame set on the table beside the apparatus. "We listened to speech and music from Philadelphia, Newark, Schenectady, Pittsburgh and Great Lakes. Even the high tension wires along the Pennsylvania, where the road is electrified, between North Philadelphia and Paoli, a suburb, did not interfere with receiving."

To Electrify Portion of Mexican Railway

Information has been received that at the recent annual meeting of the shareholders of the Mexican (Vera Cruz) Railway Company, held in London, England, provision was made for electrifying the thirty miles of mountain division of the road between Orizaba and Esperanza. The announcement of the proposed improvement came from Vincent W. Yorke, of London, chairman of the board of directors. The electric power for operating trains on this portion of the line will be obtained either from the hydroelectric plant of Lord Cowdray and associates situated near Orizaba or an entirely separate plant will be built by the railroad, it is stated. Mr. Yorke further said that at the shareholders' meeting

the action of the Mexican (Vera Cruz) Railway Company in obtaining a concession for a proposed railroad to run from a point on its Mexico City-Vera Cruz main line to Tampico was ratified and that financial provision for the early construction of this new line has been made. He announced that the cost of its construction would be approximately $8,000,000 United States currency. Both of these projects are to be carried out irrespective of whether or not the administration of President Alvaro Obregon is recognized by England.

A 50-Cycle Super-Power System for France

The manner in which the generation and distribution of power is to be consolidated in France is described in a publication under the name of The "Union d'Electricite" and the Gennevilliers Station, published by the Revue Industrielle, 57, Rue Pierre-Charron, Paris.

The Technical Company and "Union Française d'Electricite" has laid the basis of a large program as follows:

(a) To join together the various distributing companies, and to establish large generating stations producing power under the best conditions.

(b) To standardize distribution, leaning towards the adoption of standard 3-phase, 50 cycle current.

(c) To relieve the distributing companies from the necessity of keeping up and enlarging their generating plants and to permit them to devote all their activities to the development of distribution.

(d) To prepare in the future for the use of hydroelectric power.

The publication also describes the Gennevilliers Power Station, which has an initial power equipment of 200,000 kw. and which is located on the bank of the Seine in the village of Gennevilliers about four miles from Paris.

Electrification of the South Eastern & Chatham Railway, England

Plans and negotiations are being made for the purpose of obtaining a supply of electric power for the electrification of the South Eastern & Chatham. The railroad company has applied to the Electricity Commissioners for consent to the establishment of a 60,000-k.w. generating plant at Angerstein's Wharf, Charlton. The West Kent Electric Company Limited also applied for consent to build a 150,000-k.w. generating station at Belvedere in the urban district of Erith. During the course of the inquiry, offers to supply the railroad company were made by the West Kent Company and by the County of London Electric Supply Company.

An important factor in this case is the forthcoming grouping into one railway system of the London & South Western, the London, Brighton & South Coast and the South Eastern & Chatham Railways. The London & South Western Railway Company is supplied with electric power from its 25 cycle generating station at Wimbledon. The London, Brighton & South Coast purchases energy from the London Electric Supply Corporation. The further electrification of that railway's suburban lines will entail a supply which will be many times in excess of that now furnished by the London Electric Supply Corporation and this additional supply must be supplied at a frequency of 25 cycles, for the reason that the equipment of the company's rolling stock is designed for that frequency. The South Eastern & Chatham Railway Company also desire a supply at 25 cycles, but as their system of electrification will be direct current, a supply at a frequency of 50 cycles is also practicable.

It is expected that the first stages of the electrification of the South Eastern & Chatham will be completed by June 30, 1925, and arrangements have been made with the Treasury for a guaranteed loan of £6,500,000, five millions of which are to be expended on the electrification of the lines. This financial assistance is dependent upon making arrangements for an adequate power supply. If the railway company purchases its power from an outside source, it will be relieved from a capital outlay of something more than £1,000,000.

Personals

A. W. Donop, formerly Pacific Coast district manager of the U. S. Light & Heat Corporation, with headquarters at San Francisco, has been appointed district manager in the railway department of that company, with headquarters in Chicago, to succeed E. C. Wilson. Mr. Donop has been identified with electric car lighting since its inception, having operated and maintained some of the original headend equipment on Pullman cars. He entered the service of the Pennsylvania at the time when that road established a carlighting maintenance department. He later was in the employment of the Gould Storage Battery Company, and the Lehigh Valley, respectively. In 1907, he entered the service of the U. S. Light & Heat Corporation, with which organization he has been chief inspector, traveling engineer, and a district sales representative.

A. W. Donop

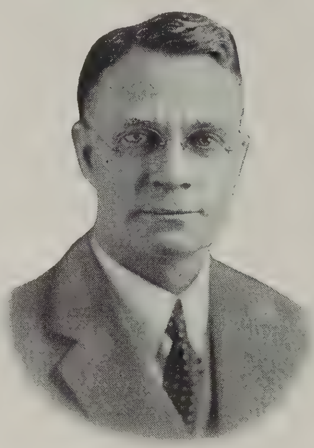
Charles N. Wiltbank has been appointed sales representative for The Bryant Electric Company in the Middle Atlantic States.

Mr. Wiltbank was for two years the assistant purchasing agent for The Philadelphia Electric Company, supply department, resigning his position during the early days of the war to become purchasing agent of electrical supplies at the Hog Island plant of The American International Shipbuilding Corporation.

In 1918 he joined the Signal Corps of the Army and devoted his efforts to development and construction work on trench telephones. After his discharge from the Army he represented the Westinghouse Lamp Company in the Franklin Division, resigning in 1919 to become district sales manager in Philadelphia and Eastern Pennsylvania for The Manhattan Electrical Supply Company.

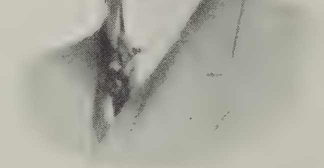
Mr. Wiltbank will represent The Bryant Electric Company in southern New Jersey, eastern Pennsylvania, Delaware, Maryland, District of Columbia, Virginia, West Virginia and North Carolina.

W. S. Rugg, assistant to the vice-president, has been appointed general manager of sales of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. The position of general sales manager is a new one in the Westinghouse Company and Mr. Rugg was appointed to the position because of his long experience in the electrical industry and in sales work. Mr. Rugg was born in Broadhead, Wis., and was graduated from Cornell University. He entered the service of the Westinghouse Electric & Manufacturing Company in 1892 and three years later was transferred from Pittsburgh to the Chicago office as district office engineer. In 1901 he was transferred to the New York office as special sales engineer, and in 1909 was made manager of that office. He was again transferred in 1917 to the East Pittsburgh works and was appointed manager of the railway department and shortly after he became manager of the marine department also. In 1920 he was promoted to assistant to vice-president in charge of sales, and now becomes general manager of sales as above noted.



W. S. Rugg

B. F. Bardo, whose appointment as superintendent of electric transmission on the New Haven was noted in the September issue of the *Railway Electrical Engineer* is in charge of operation and maintenance of the wire plant between New York and Cedar Hill, with headquarters at Cos Cob, Conn., reporting to H. A. Shepard, general superintendent of electric transmission and communication. Mr. Bardo was born in Wilkes-Barre, Pa., December 16, 1889. He was educated in the Morris High School, New York City and Cornell University, graduating from the latter with a degree of mechanical engineer in 1913. After graduation, he served for a little more than a year in the testing department of the General Electric Company at Schenectady, N. Y., and at Pittsfield, Mass. In August, 1914, he entered the services of the New Haven Railroad and was employed in the office of the superintendent of power. In October, 1915, Mr. Bardo was appointed inspector of power plants and in November, 1917, was made engineer of power plants, serving in that capacity until his present appointment.



B. F. Bardo

Frank Kerswell has resigned as chief electrician, Southern Pacific Lines in Mexico and is now electrical foreman, Main Shops, St. Louis-San Francisco Railway, with headquarters at Springfield, Mo.

Trade Publications

The Roller Smith Company, New York City, is distributing its four-page, illustrated bulletin, describing portable direct current galvanometers, types LGD and KGD. These instruments were designed primarily for laboratory work.

The Electric Furnace Company, Salem, Ohio, manufacturers of Baily's Electric Furnaces, is distributing two illustrated, six-page folders, describing the details of its equipment and showing a number of installations of furnaces.

Relays.—The operation and general application of various types of relays manufactured by the General Electric Company, Schenectady, N. Y., are described in bulletin No. 47606 just issued by that company. The bulletin is illustrated with diagrams and contains 28 pages. A table of applications of standard relays is included to assist in giving a general idea of the different types and applications of the more common relays.

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has just completed the preparation of a 64 page illustrated publication on mining apparatus. In addition to line material, the publication, which is known as *Catalogue 6-M,* contains much information about mine safety switches, Frankel solderless connectors, tapes, babbitts, solders, micarta gears, mine locomotives and mine locomotive headlights.

Electric Car Lighting Fixtures.—A catalogue under the title of "Electric Lighting Fixtures" has recently been issued by the Safety Car Heating & Lighting Company, 2 Rector street, New York, which describes and illustrates electric car lighting fixeures made by that company. The catalogue is profusely illustrated in two colors and contains 85 pages. The fixtures illustrated do not cover the entire line of Safety designs. They do, however, include those which, by virtue of the demand for them, would seem to represent the mapority preference of railway men and the approval of the traveling public.

Lighting System Maintenance.—A 12-page pamphlet under the title of "Lamp Maintenance Equipment" has been issued by the Thompson Electric Company, Cleveland, Ohio. The booklet illustrates and describes the safety disconnecting hangers manufactured by this company, including methods of wiring and the application of various types of reflectors. The reasons for cleaning reflectors and the risks which may be involved in doing so are described and particular stress is laid to the suitability of the hanger where the lighting units are placed close to moving belts or above traveling cranes.

Railway Electrical Engineer

Volume 13 NOVEMBER, 1922 No. 11

Combined Electrical Power Distribution

An economical combination of electrical power distribution has been worked out successfully on a certain eastern railway. A 6,600-volt alternating current distribution line extends along the right-of-way over several divisions, power from this line being used not only for the operation of the automatic signals and interlockers, but also in the illumination of all stations, freight houses, etc. Special starting compensators and transformer equipment are provided at coaling plants and water stations to permit the starting of the motors without reducing the line voltage to such an extent as to cause the signals to be released. No watt-hour meters are used at the passenger stations because the fixed charges on the investment and the time required for reading the meters would amount to more than the total cost of power used for the illumination. Definite instructions and close inspection have been found effective in influencing the station agents to turn off the light whenever practicable.

Where a group of switches are at all close to a transformer location, the switch lamps are electrically lighted. Such a diversified use of the power has resulted in an extensive saving in power bills and increased convenience and economy of electric lighting and power at many points that would otherwise be isolated but for the railroad's own distribution system. By generating the power at certain central points or by buying the power from public utilities in large quantities, very favorable rates may be obtained. One important factor in designing such a distribution is to consider well all the possible load to be thrown on the line; otherwise it is found that the line will soon be loaded beyond capacity. In view of the several advantages of a railroad's own power distribution system, would it not seem advisable for railroad electrical officers to make an investigation to determine the cost of power required at various points along the line and in consultation with signal officers to work up a combination that will result in a large total saving to the railroad.

Past, Present and Future

Away back in November, 1908, a few men, drawn together by common interest, met and formed the Association of Car Lighting Engineers. The name was most significant, for it indicated that the scope of electrical endeavor was almost exclusively confined to the illumination of railroad cars. As a matter of fact, in those early days the problems of car lighting were many and vexatious and required the undivided attention of the men engaged in the work. Even then, however, they were not unmindful of the greater future development in the electrification of railroad shops, shop lighting, station lighting and electric traction. Electric welding was practically unheard of at that time.

At the second annual convention of the Association of Car Lighting Engineers, the name of the organization was changed to that of the Association of Railway Electrical Engineers. The wisdom of this change has been most apparent as the years have gone by. The electrical men still have car lighting problems to discuss but they are not of the heart-breaking nature that they used to be. Year by year improvements have been made until the electric illumination of railway coaches is accomplished with as much efficiency and certainty as the actual operation of the train itself.

Fourteen years have passed since the first meeting of the association was held and in these 14 years the duties and responsibilities of the electrical men have increased many-fold. Of all the factors connected with this growth and development, there is none more gratifying than that the electrical men themselves have broadened out to meet the increased responsibilities. They are successfully coping with the electrical problems of every railroad department. Nor is the end in sight, for there is nothing more certain than that electricity will be the predominant factor in railroad operation of the future. As economies become more and more imperative, there can be no other answer. Large quantities of electrical material have been purchased by the railroads in the past but what has gone before is like the proverbial drop in the bucket compared with the vast amount of equipment that is bound to be installed within the next few years. The future for the electrical engineer looks very bright indeed. He is destined to become a very important officer in the efficient and economical operation of the railroad of tomorrow.

Crane-Type Electric Trucks

Electric trucks of the crane type were considered at length at the recent convention of the Association of Railway Electrical Engineers. Trucks having sufficient capacity and booms long enough to enable them to handle locomotive front-ends and air pumps were highly commended. Comparatively few railroads have tried them, but those that have, have found them to be time and money savers and more trucks have been purchased because of their satisfactory operation.

With the aid of a crane truck only two men are required

besides the truck operator to remove or apply an air pump, a side rod or a front end. In one engine-house on the New York Central, it has been found possible with a crane truck to take a repaired air pump from a car to the engine-house, take off the crippled pump, put on the repaired pump and have the crippled pump on the truck ready to be returned to the back shop in 25 minutes. Only three men were required to do this.

There has been some question as to how large an engine-house must be in order that such a truck may be kept busy all of the time. In some large engine-houses two trucks are scarcely adequate and while some houses would not have enough work to keep a truck busy all of the time, it is quite possible that in view of the large savings that can be made, a truck would effect economies, even in part time service. In a few cases, the crane trucks in use have been tipped over and the batteries spilled. This has been caused, however, by careless operation—by lifting large loads without the use of the outrigger, for instance—and it is something that can be avoided without great difficulty.

The crane truck has to compete with traveling cranes or hoists or with chain blocks. The traveling crane is practically out of the question, since in most cases there is not enough work to warrant the expense of its installation. The traveling hoists are effective, but their range of action is limited. Chain blocks are not costly, but their use means rigging them in each case to the roof structure and in most cases moving the locomotive. There is much heavy lifting and carrying to be done in the average engine-house, and the crane type truck seems particularly suited to this class of work.

The Reward of Initiative

The outstanding feature of the 1922 convention of the Association of Railway Electrical Engineers may be most pertinently summed up in the one word "growth." The men who once gathered to discuss problems of a comparatively narrow field are successfully handling the larger problems in a truly remarkable manner. They are giving evidence of latent capabilities which the rapidly expanding applications of electrical energy are demanding in no unmistakable terms. From car lighting to heavy electric traction is a far cry. True, the fundamental principles of each may be similar but the problems to be wrestled with in the consideration of electrical traction are big and complex and require quite a different kind of vision than those involved in a small 2 kw. or 3 kw. traveling power plant even though it may be automatic in its operation. That the members of the association are fully cognizant of the growth in the scope of their activities is shown by the masterly report of the Heavy Electric Traction Committee. A great wealth of valuable data is gathered in this report, which will be kept as a reference by all engineers interested in the subject.

The subject of Electric Traction is so large that it has attracted the interest of some associations which really have no direct interest in the railroad field. In view of this fact it is particularly gratifying to see the railway electrical engineers take hold of the subject, which is undeniably their own, and handle it in such a comprehensive fashion.

Many of the other reports presented at the convention show unmistakable evidence of mature thought and study. Needless to say, these factors are surely and irresistibly raising the standards of the Association of Railway Electrical Engineers. Railroad electrical applications, both great and small, are within the province of Railway Electrical Engineers and it cannot be denied that they are rising to the situation in a manner that is bound to bring honor to themselves and to their association.

Keeping Motor Records

A practice which is in vogue on a number of roads and one which has much to recommend it is that of putting a serial number on motors when they are first purchased. Too much can scarcely be said in favor of this means of keeping a line on the life and maintenance of motors in railroad service, for while motors are usually purchased for some particular duty at a specific point, it is quite common for them to be pressed into emergency service at other points many miles away from the original location. When the emergency has passed, it not infrequently happens that for one reason or another, the motor is not sent back to its original location and in fact it may even be shipped to still another point on the system. Under such conditions as these, it is evident that some means of accurately recording the various repairs made upon such a motor is of utmost importance and there is perhaps no better way than to have a serial number stenciled on the motor and a corresponding record card kept in the office of the electrical engineer.

In this way any repair work that is performed on the motor, such as rewinding armature or field coils, renewing brushes, turning down the commutator, etc., can be correctly charged to the particular machine. The record of the expense involved together with the extent and nature of the work done can be forwarded to the office of the electrical engineer where the items can be put on the proper card.

New Books

Standard Handbook for Electrical Engineers.—Fifth edition, 2137 pages, illustrated. 4½ in. by 7 in. Bound in flexible imitation leather. Published by the McGraw-Hill Book Company, New York City. Price $6.00.

The fifth edition of the Standard Handbook is now available at a reduced price. For about a year, no copies of the Standard Handbook have been available as the fourth edition ran out of print in the fall of 1921. The general arrangement of the book is identical with previous editions and the text is similar. There has, however, been a growth of 203 pages.

American Electricians' Handbook.—By Terrell Croft. Second edition 823 pages, 900 illustrations. Bound in cloth. Published by the McGraw-Hill Book Company, New York. Price $4.00.

The first edition of the American Electricians' Handbook was published in 1913. The second edition, which is now available, covers much of the same general subject matter, but it has been considerably revised. Parts of the book which have become obsolete have been discarded and approximately 100 new pages have been added. The entire book has been modified to conform to the National Electric Code requirements for 1920. The author is known as a writer who can explain electrical matters to the practical electrician without extensive training in the fundamentals of electrical engineering and this book is one on which he has based much of his reputation.

Looking North From the Engine House Roof

Power and Lighting Facilities on the Erie

Enginehouse and Shop at Jersey City Equipped with Modern Electrical Devices for Economical Operation

ON September 11, 1921, the enginehouse and local shop of the Erie Railroad at Jersey City was destroyed by fire. Together with damage done to locomotives, the total loss was approximately $100,000. The volume of suburban passenger traffic at this terminal is so great that the handling of the large number of locomotives required immediate construction of buildings to provide the necessary facilities. These buildings have been erected and while the electrical work is not altogether completed, enough is finished and in operation to point out some of the more important features of this installation. All of the electrical construction work was installed under the supervision of George Eisenhauer, electrical engineer; George Hamilton, supervisor of Electrical Repairs; L. L. Dawson, chief electrician, and F. J. Houck, assistant chief electrician.

Power Supply

The railroad purchases its power from a public service company which supplies energy at 2,300 volts, 2-phase, 60-cycles. The power cables are brought into the building through two 3-in. conduits from the pole line on the street, the conduit running down the pole, under the sidewalk and up the inside of the building. Each conduit carries one No. 2 B and S duplex lead covered cable.

The Switchboard

The switchboard is constructed of nine panels of Johns-Manville ebony asbestos wood. It is located in the machine shop on a balcony about 10 ft. above the floor. The panel at the extreme left is the meter panel. Upon this panel are mounted a test switch, a graphic meter and a recording watt hour meter. The next panel contains the main 2,300-volt switch. The third, is the starting panel for the 2,300-volt synchronous motor used to drive the air compressor, while on the fourth panel are mounted two 2,300-volt oil switches, one controlling power to a machine shop located no the north side of the yard and the other controlling the circuit leading to the power house to be used in case of emergency. The fifth panel carries a switch through which the 2,300-volt power is brought to six Westinghouse transformers located on the floor under the switchboard balcony. At the present time, four of these transformers are 25-kw. capacity and two of them 50-kw. capacity, but it is expected that the load will be increased in the near future to such an extent as to make it necessary to replace the 25-kw. transformers with others having 50-kw. capacity.

From the low tension side of these transformers, 220-volt power goes to a three pole main knife switch on the sixth panel from whence it goes to panels seven and eight. On panels seven and eight are mounted the distributing switches for power applications and panel nine is similarly arranged for lighting circuits, except that the energy is reduced from 220 volts to 110 volts through 2 balance coils which are situated near the 6 transformers, below the switchboard.

Enginehouse Wiring

Many ways have been devised in various engine houses to escape the inevitable destruction which occurs when wiring is installed in conduits located above the gas line, but perhaps none of them is more effective than that which has been adopted on the new Erie enginehouse. From the lighting panel on the switchboard the conduit is led out through the brick wall and along the ex-

terior of the building. At the point where it leaves the building, 2-in. conduit is required to carry the wiring but the number of wires becomes smaller as the conduit line proceeds and consequently smaller conduit is used. From this conduit line three Crouse-Hinds 16 circuit Safety Distributing Panels of the push-button type are supplied. These panels control 16 circuits averaging four lamps per circuit.

At points where it is necessary to run wiring above the gas line, it is accomplished by mounting the wire on glass petticoat insulators supported on the rafters. Where the wires drop down to a distributing panel or outlet, vertical lengths of conduit are used terminating in a type F Crouse-Hinds Condulet at the top.

On the inside of the outer enginehouse wall, between each stall, two lighting units are installed, each unit containing a 100-watt lamp. The unit used is the Crouse-Hinds Type RM. Reflector. The wiring for each pair of units is carried in ½-in. conduit to a junction box placed between and a little above the two units and from this box short runs of conduit lead to the right and left and enter the bottom of each lighting unit. The units themselves are mounted on two pieces of ¼ x 1½ in. strap iron attached to the brick wall. This arrangement permits the strap iron support to be bent away from the wall so that the light beams from the units may cross each other. Not only do the light beams cross but the bending of the supporting iron is such that the light is inclined slightly downward making an angle of about 15 deg. with the floor.

On the inside of the inner wall between the doors,

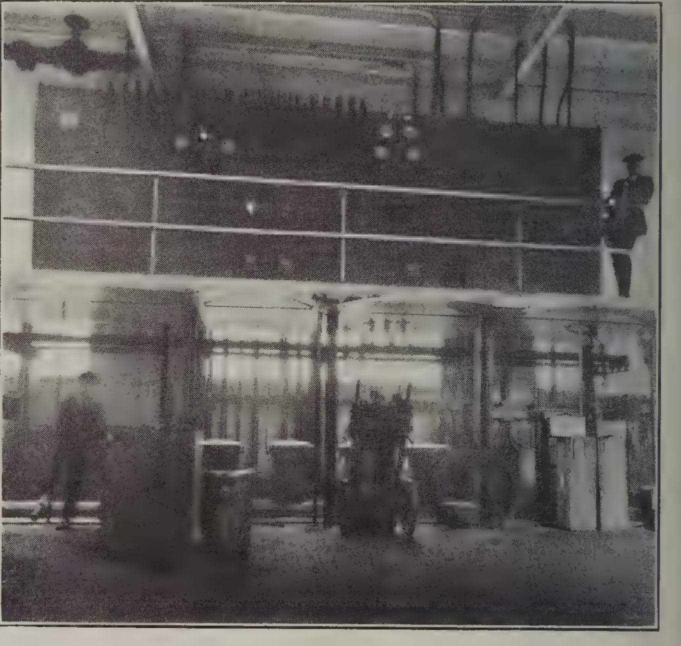
From the Street the Engine House Does Not Assume the Appearance of a Roundhouse

there is a single lighting unit mounted of the same type as the others. The circuits supplying these lamps are brought in conduit over the roof of the roundhouse and down on the outside of the inner wall. It is then led through the wall to a point close to the lighting unit and in this way contact with corrosive gases is avoided. The single lighting units are mounted on a flat wedge-shaped wood block in such a way that they are tilted downward to the same degree as the double units mounted on the opposite wall.

Three flood lighting units Crouse-Hinds Type SCE 12″ reflector mounted on the roof direct their beams upon the turntable. These units are also supplied from a conduit line brought over the roof and are controlled from the 3 different panel boxes which are located in enginehouse.

Power House Distribution

The power house, which is located near dock 5 generates 2,300 volts 3-phase 60-cycle with two Westinghouse gas engines, producer gas type. There is also a tie-in switch from the power house to 2,300 volts from the switchboard in the enginehouse. The power house is lo-



Switchboard Balcony Showing Location of Transformers Below

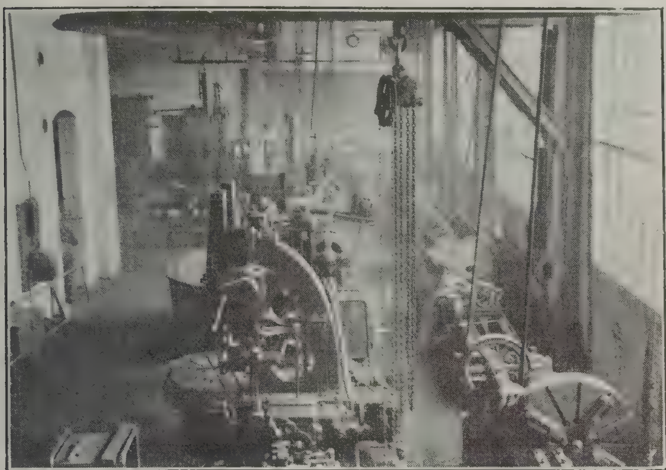
cated very much nearer the passenger station and it is economically possible to step down the power to 110 volts for lighting about the station. The 25 kw. transformers used for this purpose are located on a pole near the station. There are also a number of milk platforms in the station area which are lighted from the 110-volt circuit also being stepped down by transformers located near them.

From the power house, four docks on the Hudson River front are supplied with energy at 2,300 volts, each dock being provided with a transformer which steps the voltage down to 110 volts. No current is used on any of the docks for any other purpose than lighting.

While the major part of the wiring and equipment is alternating current, there is a small demand for 110-volt direct current. This is met by the installation of a motor generator set in the power house. A 7½-hp. 220-volt a. c. induction motor is belt connected to a 110-volt d. c. generator which supplies a circuit carrying a load of about 15 amperes. This current is used for a number of small d. c. motors such as an exhaust fan and dish-washing machine in the station restaurant, a blue printing machine used in connection with the drafting room, and as charging current for storage battery used in operating the telegraph and telephone lines of the company. This machine supplies the charging current for the storage battery used in connection with the fire alarm system, and also operates

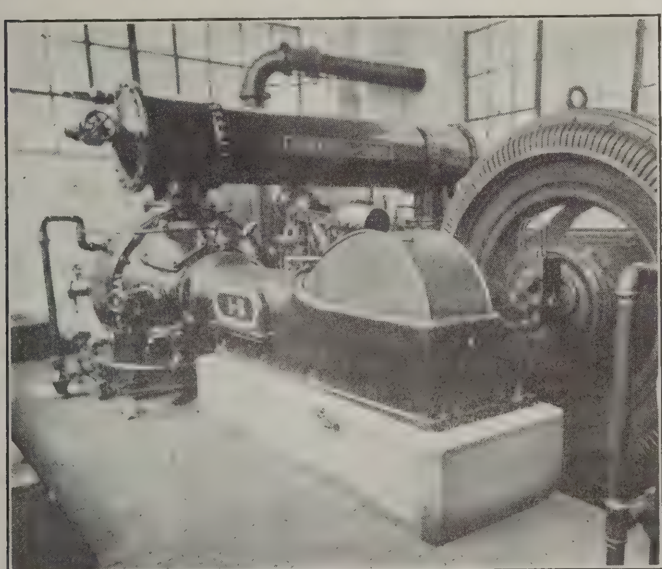
the telautographs which are located in the terminal tower and various locations through station.

The yard lighting is accomplished with the use of General Electric Company Series Novalux Pendlum units supported high upon poles about the yard. The lamps are designed for the use of 250 candle power four ampere series burning tungsten lamps and the circuit in which



View of Machine Shop from Switchboard Balcony

they are connected is a 2,300-volt line from the power house. There are 55 lamps used in lighting the yards and the lamp sockets are of the automatic cut-out type. The lamps are supported so that they can be lowered for cleaning and renewals but the sockets do not disconnect them from the line when the lamps are lowered. With the exception of renewals that may be required at night,



Compressor Driven by 2,200-Volt Synchronous Motor

the yard lamps are inspected in the day time when the circuit is dead.

Synchronous Motor Driven Air Compressor

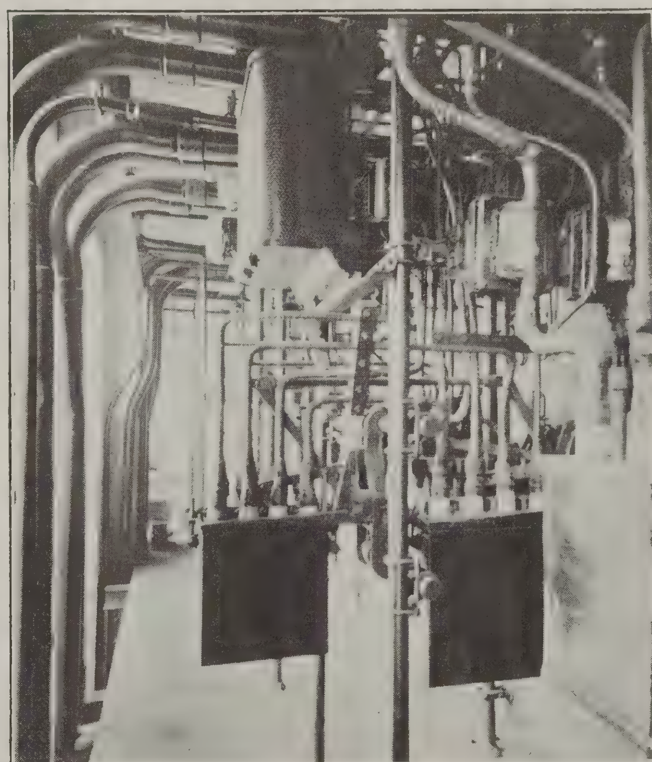
One of the 2,300-volt lines leading from the switchboard in the machine shop supplies power to a 260-hp. synchronous motor which is direct connected with an Ingersoll Rand air compressor. The compressor supplies air at 100-lb. pressure for use in the terminal electro-pneumatic interlocking plant, for charging train lines and for various shop requirements. As would be expected, the operation of this motor assists materially in maintaining a high power factor.

Power for the Coal Dock

For some time, the coal dock bucket conveyor was operated by a gasoline engine but more recently a 220-volt line run from the machine shop switchboard supplies energy to operate a 100-hp. Westinghouse induction motor.

Welding Facilities

Facilities for electric arc welding in the enginehouse are furnished by two welding sets of the Wilson type. Each of these sets is connected through a welding regulator panel to welding feeder cables which are run overhead through the building. At each stall a tap is made



Arrangement of Wiring and Conduit Behind the Switchboard

from these lines and the extension brought down the supporting column and terminated in an Anderson type N, 150-ampere charging receptacle. The welder simply plugs his welding lead into the receptacle, removing it when the work is done. Each welding machine has sufficient capacity to supply two welders, that is, four welders may work simultaneously. The welding feeder cables used are four in number, consisting of three 500,000 circular mil cables and one common return cable having a cross section of one million circular mils.

Machine Shop Equipment

The majority of machine tools are belt driven from the countershafting which is operated from a 50-hp. General Electric 220-volt, 2-phase motor, located on a bracket supported platform. Two large turret lathes, however, have individual motor drives. A Bullard turret lathe is driven by a Westinghouse 220-volt, 7½-hp. motor and a Col-

burn turret lathe is operated by a 15-hp. motor of the same type. In each case the starting boxes are located on the wall and the conduit running under the cement floor brings the wiring to the motor: A 30-hp. motor is carried as a spare machine in the event of a breakdown of the 50-hp. machine which normally runs the shop. The spare motor is also mounted on a bracket platform high upon the shop wall and is ready for service on short notice should the occasion require.

A large blower fan is located in one end of the machine shop just opposite the switchboard. This fan is driven by 40-hp., 220-volt Westinghouse motor of the slip ring type. Its speed is regulated by varying resistance units operated by a controller located in the fire room. An overload circuit breaker also forms a part of this installation.

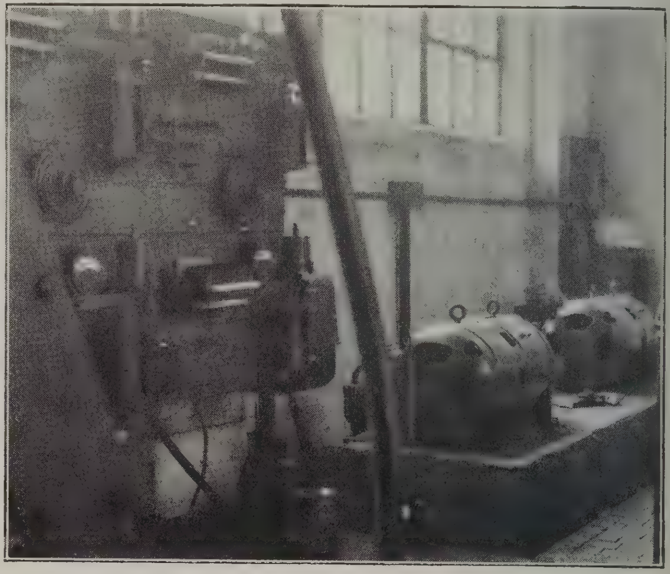
Time Keeping Facilities

In the general foreman's office is located one of the master clocks of the Stromberg system. This clock operates two other secondary clocks, one in the machine shop and one in the roundhouse. In addition to the two clocks, there are also installed a number of recording machines used in connection with employees' time cards, from which is computed the wages due the men. Both clocks and recording devices are operated by the master clock through a 12-volt d. c. circuit, the energy being derived from six small cells of a storage battery which is charged by small Tungar rectifier from the 110-volt a. c. lighting circuit.

The lighting in the general foreman's office at the present time is temporary but plans for the near future include the installation of Brascolite units with 500-watt lamps.

Turntables

One small turntable suitable only for the smallest locomotives is located a short distance away from the enginehouse. A larger table 80 feet long is used in the enginehouse circle. Both of these tables are operated electrically from a 550-volt d. c. circuit supplied from the Public Service Company's lines nearby. The smaller table is turned by a motor at the center while the larger one is equipped with a Westinghouse tractor motor at one end under the



Part of Welding Panel and Generator Units

operator's cabin. Both motors are operated with drum controllers.

The power circuit is brought to the large turntable through an overhead collecting device located in the center of the turntable and spanning the track. Both collector and supports are of the George P. Nichols Company manufacture.

A Transcontinental Train on the Canadian Pacific

Railway Electrical Engineers Meet in Chicago

Thirteenth Annual Meeting of the A. R. E. E. Finds Extensive Utilization of Electric Energy by the Railroads

THE thirteenth annual convention of the Association of Railway Electrical Engineers was held at Hotel La Salle, Chicago, October 31 to November 3. This is the first annual convention which the association has held since October, 1920. A half-day session was held in Atlantic City last June, but with this exception the recent meeting is the first get-together of the electrical men for two years, the regular fall convention having been omitted last year on account of the business depression which prevailed at that time.

In view of the labor difficulties which have existed during the past months it was questionable for a time whether or not the convention would be well attended. As the convention dates drew near the railroad troubles were solved to some extent and the actual registration at the convention surpassed expectations. More than a hundred electrical officers registered and many more attended the sessions who did not register.

TUESDAY SESSION

The first session of the convention was called to order by the president, L. C. Hensel, Frisco Lines, at 10.30 a. m., October 31. In opening the convention, Mr. Hensel spoke as follows:

"Gentlemen and fellow members of the Association of Railway Electrical Engineers:

"It gives me great pleasure to welcome you to this, our thirteenth annual convention.

"I know we will all profit by hearing the reports and discussions regarding various subjects covered by our committees and hope you will all feel free to enter into these discussions after the reports have been read.

"As you all know, we did not hold our annual convention last year, due to the unsettled conditions prevailing throughout the nation. Your executive committee gave considerable thought to this matter, and, after lengthy discussion, decided that it would be to the best interests of all concerned that we postpone the meeting until this year. This action was appreciated by all railroad executives, as they realized that all of the men's time was required in performing their regular duties on their respective roads.

"We have all gone through some very troublesome times during the past two years, but are now over the hill and the future appears very bright.

"During this convention the mornings will be devoted to our meetings in this room and I hope that you will all attend each session. The afternoons have been left open so you may have time to see the various exhibits shown by the manufacturers who have gone to considerable trouble and expense to provide them. I hope you will spend considerable time in inspecting these exhibits and thereby become familiar with the latest electrical and mechanical appliances used in railroad work."

Immediately following the address of the president, the reports of the secretary and auditing committee were presented and accepted. The financial report read by the secretary is particularly gratifying, showing as it does a balance of $2,259.36.

As unfinished business the question of the affiliation of the Association of Railway Electrical Engineers with the American Railway Association was brought up. It will be remembered that the question was first broached to the A. R. E. E. at the convention in the fall of 1919. Since that time, for one reason or another, the affiliation has not taken place, perhaps on account of the differences of opinion as to just what the status of the A. R. E. E. would be in the combination. It was felt by some that the A. R. E. E. should become a part of the Mechanical Section of the A. R. A., while others thought it should belong to the Engineering Section. At all events, the matter is still in abeyance and it is not altogether impossible that the electrical men could accomplish the best results and derive the greatest benefits by standing upon their own feet, so to speak. At any event, whatever may subsequently develop in the situation will be taken care of by a very able committee, consisting of J. R. Sloan, chief electrician, Pennsylvania System; L. S. Billau, assistant electrical engineer, Baltimore & Ohio; J. A. Andreucetti, assistant electrical engineer, Chicago & North Western, and E. Wanamaker, electrical engineer, Rock Island Lines.

Data and Information Report

E. A. Lundy, *Railway Electrical Engineer,* chairman of the Committee on Data and Information, presented a very comprehensive report giving extensive tabulated information showing the extent to which electrical equipment is being used on the various railroads throughout the country. This report is the first of its kind that has been presented since 1918, and the figures given show a remarkable increase in the use of electrical apparatus. One field in which this increase is particularly noticeable is that of electric arc welding. It is plainly evident that the roads are coming to realize the economic advantages of electric welding and it is only a question of time when this work will be common practice on all roads.

The report was accepted as read. There was no discussion.

WEDNESDAY SESSION

Power Trucks and Tractors Report

The first report on Wednesday was that of the Committee on Power Trucks and Tractors, which was presented by L. D. Moore, of the Missouri Pacific, chairman of the committee. In presenting the report, Mr. Moore said: "Your committee submits its report which covers the description, application and cost of power trucks and tractors. The report is printed in the *Railway Electrical Engineer* in detail, so that it is not necessary to read it, as it would take too much time. The principal thing that I would like to emphasize is that in a subject of this kind the conclusions reached are for the most part general and may be altered in particular cases. The committee being an electrical committee, for the most part,

did not see a very wide field of application for gasoline equipment, where it should be given preference over electrical equipment, but there may be places where gasoline equipment would be the best thing to use and better than the equipment recommended by the committee."

E. H. Hagensick (Union Pacific): "I would like to ask in regard to the crane type truck shown under Figure 13, page 331, if any of the members here have had any experience with that type of truck."

John Carlson (N. Y. C.): "We have at the present time in service three of this type, one at the DeWitt engine house, one at Solvay, New York, and one at West Shore, East Buffalo. We find they are one of the biggest labor-saving machines that has ever come into our hands. We have no trouble handling pumps, front ends, driving rods, or anything of that nature. The capacity of those trucks that we have in service is 3,000 pounds at six-foot boom radius. The machines are of the Elwell-Parker type, and are equipped with outrigs so that the danger of the machine tipping over with the outrigs is very remote. The machines on the eastern end of the division, that is at DeWitt and Solvay, have been in service possibly two months, and the one at West Shore, East Buffalo, has been in service about three weeks. We have an operator on each shift. We do not allow everyone in the engine house to operate these trucks. It is the duty of this man to operate these trucks and take care of the trucks, replenish the water supply in the batteries, as well as to look after the charging. The object of that is to assure the most successful operation of the truck, and, judging from our experience so far, I do not think we are going to have any trouble."

Mr. Hagensick: "Do you use the truck in the roundhouse exclusively?"

Mr. Carlson: "We use it anywhere we can get it."

Mr. Hagensick: "That is what I am getting at. With the ordinary house as it now exists, do you have any trouble getting around or do you have to move your engine back and forth?"

Mr. Carlson: "No, we do not have to move the engine at all. The engine houses that have been constructed within the last two or three years have a great deal more space between the pits than the older type construction and it is easier to get around with a truck."

Mr. Hagensick: "How do you take material from the roundhouse to the back shop or to the machine shop?"

Mr. Carlson: "That can be done without carrying it on the boom, simply putting it on the platform of the truck."

E. Marshall (Great Northern): "I would like to ask if this truck is in use for anything like 100 per cent of the time."

Mr. Carlson: "Well, that would all depend upon the size of the engine house. Now, the house at Solvay, New York, a suburb of Syracuse, is, as I recall it, a forty-two stall house, and the one at West Shore, East Buffalo, is a thirty-five stall house, and at DeWitt it is a twin house. Those are large engine houses, so you see at those points there is enough work to keep a truck going."

Mr. Moore: "I would like to ask Mr. Carlson about how many mechanics they can get by with in the handling of equipment with this crane."

Mr. Carlson: "I will give you a few illustrations. In order to apply the pump or front end, it would require anywhere from five to six, besides a house crew to handle the engine. On several occasions with the crane truck, from the time they took the pump out of the car, that is, the pump to be applied, took it into the house and took off the old pump and put on the repaired pump and had the crippled pump laying on the truck ready to be returned to the back shop, the time consumed was twenty-five minutes. Now, three men did that operation in twenty-five minutes. Now, as to the use of the truck in yard work or unloading cars or handling material, the operator and two men will accomplish seventy-five per cent more work than six men will do in that same length of time. What I mean by that is that three men in one hour will do as much work as six men will do in about two hours by hand without the use of the truck."

Heavy Electric Traction

J. R. Sloan, chairman of the Committee on Heavy Electric Traction, presented the report of the committee. An abstract of the discussion follows:

Mr. Marshall: "I notice there are some representatives of the large electric companies here in the audience, and I think we would all like to hear some remarks by them as to what is going on in the immediate future along this line of heavy traction."

Mr. Taylor (General Electric Company): "It is a rather general subject as to just what is going on. Of course, here in Chicago the Illinois Central have just given out a report that they are going to electrify their suburban service for 1,500 volts d. c. Of course, that is in the immediate future. There are several foreign jobs, one in Chile, one in Mexico, and some others in South America, but I am not particularly well informed as to just what the details of those are. There does seem to be more requests for reports on electrification just now than at any other time. More steam railroads seem to be interested in possible electrifications, and we have a number of such requests. The one thing that does not seem to be generally understood is that electrification perhaps is not generally an economic success applied to any particular division. In order to be worth while, there should be some outstanding reason for electrification, such as tunnels, or very heavy service on single track, necessitating double tracking or electrification, or heavy mountain grades, or something of that sort. It would seem desirable that in considering the electrification of any section of the line that a preliminary study be made to pick out at least the divisions or part of the division which offers the greatest possibilities for economies in electrification. I think that everybody is agreed that it is necessary for electrification—of course, it has to be paid for out of increased earnings in operation or decreased expense, because that overhead is rather high, and in order to make a really worth while showing there must be some conditions, some real outstanding conditions, which are difficult of steam operation or are preventing additional growth. When we have such a situation to work with, why, we can usually show that it is economical and desirable to electrify."

D. J. Cartwright (Lehigh Valley): "I would like to ask how many miles can you operate each side of a power house with a single station? Another question would be, assuming that you have a sixty-mile section, I want to find out how many sub-stations would be necessary to operate that section in addition to your power house."

Mr. Taylor: "I should say that two additional sub-

stations, spaced perhaps five or six miles from the ends, giving about a five or six mile stub end and perhaps have some sub-station capacity in the power house itself. Such an arrangement would permit of using as low as 1,500 volts very satisfactorily. I expect on such a layout you could operate perhaps more economically on 1,500 volts than on 3,000."

MR. SLOAN: "Mr. Chairman, I think if Mr. Cartwright will look up in the report of the committee for 1919 he will find there a very definite layout of the procedure that has got to be gone through in figuring one of these electrification jobs. It is a whole lot more involved and there is more to it than most people realize until they get into it."

MR. MARSHALL: "After having made the traffic survey and built the line to suit the conditions that the survey brings out, and if we find that the traffic doubles and triples, as sometimes happens, what is the best thing to do?"

MR. TAYLOR: "That would depend very largely upon a number of things. Assuming that traffic suddenly increased to double or perhaps two and one-half times, which was beyond the limits of the present installation, the thing to do depends upon the time, price of copper, labor, price of materials, which vary widely. A very careful study has got to be made both ways. I should think the way to do that would be to assume interspaced sub-stations, putting in additional capacity between the existing sub-stations."

Q. W. HERSHEY (Westinghouse Electric and Manufacturing Company): "The original question here was what is going on in the country in electrification, and it has practically developed into a discussion of details. I think it is worthy of review to a degree what the railroads are doing on electrification. During the war, of course, there was no money available to spend for the electrification, and all the energies were exerted to provide transportation. Following that came a peak in traffic requirements and again everybody fell in to try to move the loads. Then the depression. Then following that another peak, which we are in now, and the problem of the railroads has been from that time one more of taking care of details for the immediate necessities of the transportation requirements, so that in this country there has not been very much physical electrification work done in the last four or five years. This condition exists, that in a very broad sense the railroad managements are looking forward to preparing for the time when money will be available to provide such electrification as they will find they need. You are the electrical engineers. It would seem your part should be that of studying your problem rather than letting some outside people do it without your participation in the way I feel that you should. I want to compliment the committee and also the *Railway Electrical Engineer* for the elegant accumulation of data which the *Railway Electrical Engineer* is publishing here. I believe this is the most complete statistical data that has been offered to the public at any time since electrification has been thought of. I know that it will stand as a reference with very many of our people and others whom I have seen since having these copies available. Now, as to the problem where electrification exists, it is entirely an individual problem. It is one entirely aside from the question of system, also. The matter of sub-stations and the question of system can only properly be determined after you know the problem. That means the grades, the facilities that you must provide, the physical characteristics and everything, including that of actual traffic movement."

E. WANAMAKER (Chicago, Rock Island & Pacific): "Mr. President, I would like some information with regard to the automatic sub-station and the development of these rotary converters, particularly in regard to their ability to withstand a short circuit."

MR. HERSHEY: "Mr. Chairman, if I may, I will submit some data on some tests and experiences with high voltage d. c. machines under short-circuit conditions. On the Milwaukee system, which is 3,000 volts d. c. on the trolley wire, where we supplied a number of the d. c. sub-stations, those stations contain equipment to secure the 3,000 volts made up of two generators in series driven by an a. c. motor. Each of those generators has developed 1,500 volts across the commutator and the sum of the two makes 3,000 volts. One of the problems especially in mind was to design generators delivering this high voltage, which is rather a bad voltage to short circuit, to provide a machine that would take care of itself automatically in case of a short circuit. The characteristics of those machines are such that I believe you could go to the extreme of throwing a crowbar across the brush holders, except for the physical injury that the impact would make, without damaging the machine. They have been in service now for a number of years and so far as we know, there has never been any disastrous short circuit to those machines."

The report was accepted and the committee continued.

Electric Repair Shop Facilities and Equipment

E. H. Hagensick, of the Union Pacific, as chairman of the Committee on Electric Repair Shop Facilities and Equipment, presented the report of this committee. An abstract of the discussion is as follows:

MR. HAGENSICK: "During this last trouble on our road we have had a great deal of trouble with motors burning out, and we have gotten by simply because we had lots of spare motors. We found in many cases there was no oil in the bearings and at one coaling station, I remember, we had five motors burn out and there were some so-called electricians there, also."

MR. MOORE: "Mr. Chairman, there are two or three things that occur to me in connection with this report. One of them is the reference to synchronous apparatus for power factor correction, particularly for generation of direct current where power is purchased. On the Missoui Pacific our original installation of that sort was made with synchronous converters, but since that time we have rather come to the conclusion that motor generator sets are preferable. On a railroad where facilities are scattered over a good many hundred or thousand miles, the fact that a synchronous motor generator set can use standard transformers, such as can be borrowed from the electric company, very often is certainly a point in their favor. One of the things that we have found to be most important is the fact that the motor generator set is more readily operated inverted so as to generate alternating current in case of failure. In the matter of repair parts we find one of the most important things is brushes, not merely brushes, but the proper kind of brushes. So often brushes are simply so many pieces of carbon of certain dimensions without proper characteristics for the

service in which they are used. It seems to me that the proper determination of the brush characteristics is a pretty important proposition, and that they should be carried in stock and so listed that the proper brush will get to the proper machine. That is one of the advantages of having machines numbered. On the Missouri Pacific the valuation department has taken care of that. All machines are numbered for valuation purposes, electrical as well as mechanical, using a bronze number plate. By having each individual machine numbered it is a very easy matter to have repair parts specified for that machine, and the local electrician when ordering repair parts can simply specify 'For Machine No. ——' and the electrical engineer's office and general stores department can then look it up and furnish the proper parts."

Mr. Carlson: "With all due respect to the committee, on this article on page 325, that second paragraph, 'in the operation of terminals there is no reason why the same sized motor should not be used at all points for the same class of service, as turntables, coaling plants and so forth.' To my humble mind it seems to me that that statement is somewhat misleading or could be misconstrued. On large systems there is a great difference in the various equipments at terminals, and I believe that that should be considered as a local matter. For instance, a coaling plant that will elevate on an average 125 tons of coal an hour for a period of eight or ten hours, possibly twelve hours, sometimes longer, according to the traffic conditions, would require a heavier equipment than a coaling plant elevating or handling only three or four hundred tons per twenty-four hours. The same would apply to turntables."

Mr. Hagensick: "In regard to the standardization of motors and your speaking of coaling stations, on many roads the practice in coaling stations is to use practically the same elevating machinery regardless of the capacity of the station and simply increase the hopper capacity, if they have got a 650-ton station or an 800-ton station or a 400-ton station, or whatever it is. On our road, that is the case, at least, and the elevating machinery is practically identical. Of course, there might be, as you say, special cases where they would want to get up a lot more coal in fewer hours. That would, of course, be a special case, and on turntables this two-motor type you speak of would be a special case."

Mr. Andreucetti: "Mr. Chairman, continuing further Mr. Hagensick's remarks about spare motors, and to make the matter clearer to the gentleman who spoke previously, the idea was to check your territory for the various sizes of motors and then have one or two spare motors."

L. S. Billau (Baltimore & Ohio): "Mr. President, the practice on the B. & O. for a number of years with respect to turntable motors has been such that that is the most hopeless place in which we could secure something in the line of the standardization of motors, but we have succeeded today in adopting two sizes to take care of practically all of the turntables on the system, with a few minor exceptions where the electrical characteristics are different from the usual standard, our standard being 440 volts, 60 cycle service. I would like to bring out a point in connection with the use of brushes. A few years ago we tackled the problem on the basis that I believe has become in more or less widespread use today. We took care of our brush requirements on an annual contract basis with one company, and in that connection have had brush specification sheets prepared covering every motor on the railroad, those sheets bearing an arbitrary number and all brushes are ordered by local electricians and storekeepers by that particular specification number. In many cases we have a number stamped on the motor and the instructions are that the manufacturer will not furnish a brush unless that specification number is given. It has almost automatically eliminated what was before a very serious brush trouble."

A. J. Farrelly (Chicago & North Western): "Mr. Chairman, in regard to the question of lamps, we make a test of the voltage, and if we find that it is high, as a general thing we specify a higher voltage lamp for that particular station. We only have three voltages, the 115 for general use, the 125 for the higher voltage, and then the voltage for train lighting. We handle the brushes exactly as Mr. Billau has said. We have a number on each motor and all the man in charge of that motor has to do is to give the number of the motor and he will get not only the proper size, but the proper quality of brushes."

Charles R. Sugg (Atlantic Coast Line): "I would like to ask Mr. Billau what he is going to do five or ten years from now, when the manufacturers stop making the motors he has got now and he can't get motors to fit in the same place."

Mr. Billau: "We have already been through that. We started the standardization of these turntable motors probably ten or fifteen years ago and the type of motor that we used at that time is now obsolete. About the same time that the motor became obsolete a good many motors reached the stage of their existence where it was a question as to whether they should be continued in service, and as a consequence we then selected a new and approved design of motor, and as these older motors got into trouble they were put in other service and the new standard motor put in, and thus a gradual change brought around."

Following the discussion of the report on Electric Repair Shop Facilities and Equipment, Joseph Beaumont, vice-president of the Regan Safety Devices Company, Inc., described the construction and operation of the Regan system of train control. Immediately after his talk, a motion picture was shown illustrating how the various parts of the equipment functioned in service. B. F. Meisel, also of the Regan Company, was in charge of the projecting apparatus.

THURSDAY SESSION

Illumination Report

Mr. Billau presented the Illumination Report regarding which he said in part: "Since submitting the preliminary report in June, this schedule has been quite radically changed, which is in conformity with the practice that has been adopted by the lamp manufacturers. Train lighting lamps are now available and listed in commercial production. There are ten types and sizes in the 30-volt range for which there is a relatively large demand and six additional in which the demand is either on the increase or decrease, and eight lamps in the 60-volt range. It is hopeful as along the lines of standards and particularly the production of types of lamps to be carried in stock, not only for the railroad, but for the benefit of the manu-

facturers, that some definite effort be made towards the adoption of a limited number of sizes for general application to railroad service, and in making this recommendation I want it kept in mind that there probably always will be special cars and special conditions where special types of lamps are used. The next important feature with reference to these lamps is the question of the bulb finish. The 50-watt gas-filled lamp will undoubtedly very rapidly replace the vacuum lamp and a clear lamp under those conditions is manifestly bad from the illumination point of view. Your committee, therefore, is recommending that the 50-watt gas-filled lamp be brought out with the bowl enameled or frosted, whichever treatment may be preferable. With respect to incandescent lamps for locomotive cab and classification service, there has been an increasing demand in the past year for the development of a lamp of smaller physical dimensions. There is no reason why a 15-watt locomotive cab lamp cannot be furnished in an S-14 bulb that would give as reasonably good life as the S-17 bulb. Some effort was made to secure some data on the actual performance of the mill type lamp, but the committee was unable to secure any information that was sufficiently complete or reliable under comparative conditions to offer any information to the Association. The next subject is the question of the miniature lamps for electric hand lanterns and flashlights. I think nearly all the railroads are today using flashlights for inspection purposes through all the departments. A survey made some time ago showed that nearly every type of flashlight bulb that was manufactured commercially was in use. By a little study of the subject, it was found possible to reduce the number of those flashlight bulbs to two or three to take care of the situation. The next subject is 'Voltage Standardization.' The central station companies, through the National Electric Light Association in conjunction with the lamp manufacturers and others, have conducted a very energetic campaign throughout the country to standardize light voltages. Progress is being made in use of lamps of 110 rated voltage and 115 and 120, is rapidly gaining. While I have called attention to the desirability of reducing the number of types of voltage in use, it can be carried too far. The use of a lamp of a rated voltage where the rated voltage in the lamp is under the circuit voltage, say five volts, the use of a 115 volt lamp on a 110 volt circuit will reduce the candle power from twelve to fifteen per cent. On the other hand, the use of rated voltage above the circuit voltage, that is, using a 110 volt lamp on a 115 volt circuit, will reduce the life of the lamp about forty per cent. Consequently it is rather desirable to use a lamp that approximates very closely the circuit voltage, but in this connection it does not mean that you need to go beyond the five volt steps. In other words, the 110, 115 and 120, and in rare cases you may find it necessary to use a 125 volt lamp. We have met the situation on our road very successfully by the preparation of rather detailed instruction sheets for every division of the road, covering practically every station and building in which are listed the sizes of lamps and voltage that they are authorized to use. Those sheets are put in the hands of the stores department and they are not allowed to issue lamps to any of those places unless they conform to the size and the voltage shown on that sheet. That has been very effective in accomplishing the results that we desire. 'Revision of Standard Incandescent Lamp Specifications' is a very important matter. The vital change has been the elimination from the major life performance to the eighty per cent candle power basis. The general effect of these specifications has been to tighten up, if we may use the term, the product. It assures the product both from the candle power performance and life performance considerably better than was possible under the old specifications. There is another angle that ought to be considered in the question of increased illumination in passenger cars and it is often overlooked by the electrical men. There is no question as to the advertising features of a well illuminated car, and I mean by that properly illuminated, and while the use of an enclosing unit with possibly a lamp of rather high wattage, even a 100-watt unit in a coach which may double the coach load from around 600 watts to eleven or twelve hundred, may affect the cost of operation and maintenance of your lighting system to some extent, it is a question whether that increased cost is not far more than offset by the advertising benefits that are secured in furnishing a service that will appeal to the public."

George R. Shirk (Chicago Great Western): "I would like to hear some of the members state what results they are getting with the mill type lamp on a 230 volt circuit."

Mr. Carlson: "Regarding the use of mill type lamps, we have for the past two years or about that been using the mill type lamp in 115 and 220 volt sizes in a 50-watt size lamp. Prior to that we were using the carbon lamp and then we went over to the straight B lamp, which was a complete failure, and then came this mill type and we immediately tried them out. We find that they are the most successful lamps that we can get for all classes of portable work, and as far as our experience goes with them it is good."

Mr. Andreucetti: "How does the life compare between the two?"

Mr. Carlson: "The life is not the point of advantage, and we figure that the difference in the light given will offset the life in the lamp. Regarding the use of cab lamps, I might say that the New York Central is considering the use of a 6-volt lamp in the cab over the gages. This thing is merely in the experimental stage and no results can be given at the present time. Regarding the general illumination of yards and around enginehouses, we find that the flood lighting proposition works out a great deal better than the open type lamp."

Mr. Shirk: "I would like to ask the gentleman from the New York Central Lines where he used a particular lamp how his workmen got along where the light was suspended between them and the work."

Mr. Carlson: "In some cases we have a reflector that has a half shade and in many cases a workman takes a piece of tin and fits it into the portable guard to suit himself."

Mr. Farrelly: "Mr. President, in regard to the mill type lamp, we made an extensive test of the mill type as against the carbon lamp with the result that the carbon lamp is our standard for portable use in freight houses, roundhouses and shops."

Mr. Hagensick: "May I ask Mr. Farrelly how long ago he made that test?"

Mr. Farrelly: "About a year ago."

MR. HAGENSICK: "They have a newer type now. The first mill type that came out was no good at all."

MR. WANAMAKER: "Mr. President, just a word in reference to the mill type lamp. We began testing the mill type lamps when they made the first one. We tried the first mill type lamps and found they were very short-lived, but I want to say in the past seven months the service that we have received from mill type lamps based on the use of a great many over the entire system has demonstrated clearly that the life is very satisfactory."

Motor Specifications

The report of the Committee on Motor Specifications was read by Mr. Wanamaker, chairman of the committee. In discussing the report, he said: "Mr. President and gentlemen: This committee has worked very hard and faithfully on this report, but it won't take long to go through with it. I do not want you to think because it is short that there was not a lot of work in getting it up. I am saying that in behalf of my fellow-committeemen and the manufacturers' representatives who worked so faithfully with them."

MR. SLOAN: "I would like to ask the committee why they limited their report to the open type motors and why they did not figure on the semi-enclosed or fully enclosed type."

MR. WANAMAKER: "I think the railroad strike had something to do with it, because we realized we were undertaking quite a big task. I should probably have stated this before I read the report, that we thought if we succeeded in covering this type of motor and this size in our first attempt, that we would be covering the field to the extent of our capacity at this time. The manufacturers seemed to agree with us to that extent. The committee felt that if the Association so desired they could appoint another committee or continue the committee to go farther into the field of motor specifications."

Train Lighting Equipment and Practice

The report of the committee on Train Lighting Equipment and Practice was presented by Mr. Billau, chairman of the committee who said in part: "The report of this committee was presented practically in its entirety at the June meeting and therefore I will not take your time today to go over the same ground. The report covers primarily a brief description of practically all the forms of mechanical axle generator drives that have been developed in this country, either experimentally, and some of them are still on paper, some of the others have been actually tried out in service. The only comments I have to offer at this time are that since last June we have added three additional mechanical drives that are designated as the Canadian Pacific drive and two drives that still remain to be actually developed but are worked out in design and designated as the George C. Mill and D. C. Wilson drives. While not coming under the definition of a direct drive as was specified in this report, there has been brought out and there is being tried out experimentally a modification of a belt drive using the axle pulley with the universal joint in it. It was brought to the committee's attention rather forcefully this year that there are still two features on which standardization could be carried forward to advantage. We have three sizes of axles in general use in passenger car work and in talking to a manufacturer of this type of pulley this summer I found there were some fifteen or twenty types of bushings. The result of it is the manufacturers make no effort whatsoever to standardize bushings. They simply make up every lot that comes in. It would certainly be to the mutual advantage of the railroads as well as the manufacturers of such bushings if we had standardized types for this service. The other subject that has been developed this year has been the matter of a wide face axle pulley. One the Pullman Company are now using very widely, commonly known as their barrel type pulley, practically a crown pulley used with a center belt drive, and another pulley of straight face type, but considerably wider than those that are in general use. The reason why it is desirable for the Association to take some action on this matter is that if this wide faced pulley shows merit, and preliminary service tests with it indicate it does, the tendency of the railroads will be to begin to use them, and if each railroad attempts to order pulleys of some special dimensions to meet their own requirements without the consideration of the others, we are going to get into a chaotic situation."

MR. CARTWRIGHT: "I would like to have Mr. Lunn give us a little information if he will as to what results they have obtained on the Pullman cars in going to the drum type of axle pulley."

MR. LUNN: "Mr. Chairman, the development of the wide face axle pulley has taken about two years, nearly three years. We first started with a 20-inch pulley located off the center and used it with one of our standard body hung generators. We got such good results from the pulley with a 20-inch face that it was decided that we would locate it in the center of the axle. That brought up the question as to whether the 20-inch face was the proper length. An investigation was started, with the result that our 32½-inch pulley came out. By using the barrel type of pulley we could go to 18½ inches at center and still not go above that over the flanges. After we had gotten many of them in service and had experimented further with them we found that a 28½-inch pulley would be more serviceable, and we could, by reducing the length to that figure, bring our outside bolts outside of the end of the pulley so that you could easily apply a socket wrench without going through a hole in the pulley face. We decided also to hinge the lower end of the inside bolts. I have here a record of thirty-three cars which I will refer to; thirty-three cars with what is known as our new two point suspension, operating 221 car months, lost 158 belts. That is an average of .71 of a belt per month, which is equivalent to about 15,000 miles per belt. Thirty-three cars with safety body hung suspensions, with the narrow face axle pulley, ten inches off center, 248 car months, lost 109 belts or .43 belts per month, which is equivalent to a life of about 25,000 miles per belt. Our girder hung generators—you are probably all familiar with them—lost practically the same number as our new two point truck suspension, or .74 of a belt per month, or 15,000 miles life. Thirty-three cars equipped with our barrel type pulley lost .73 of a belt per month, or 19 belts in 260 car months. On the basis of 15,000 miles per .71 of a belt loss per month, this would run about 100,000 miles. They do not run quite that long."

MR. SUGG: "Mr. President, I would like to ask Mr.

Lunn if he can give us any information as to the changes necessary in the brake rigging to apply that belt."

Mr. Lunn: "We have to change our brake rigging so that the belt can ride freely in the clear. You have got to support your brakes from the end and not in the middle."

Mr. Farrelly: "I would request Mr. Wanamaker to give us some information in regard to the universal pulley which I understand is on test on the Rock Island."

Mr. Wanamaker: "Well, the pulley has not been in service long enough to give much information. The principle of the pulley proved itself out, but it has been applied about twenty times, I presume, on that one pulley, like anything new, and I believe that so far we have established the fact that the universal pulley principle is all right, but the wearing of the parts is something that would have to be ascertained. We are now getting ready to apply the pulley with high manganese surfaces where there is any wear. If the wearing of the parts proves satisfactory, I think it is very possible that the universal pulley deserves a wider experimental application, to say the least."

E. S. M. Macnab (Canadian Pacific): "I would like to hear from Mr. Billau on the wide pulley applied not in the center of the axle, but ten inches from the center."

Mr. Billau: "Our experience with the wide faced pulley is limited. We found that with the wider faced pulley we could shift the machine so that the center line of the belt came within four and one-half to a little over five inches from the center. We found that to do that a 24-inch faced pulley was the shortest we could use. We have a few cars equipped with those pulleys and with respect to belt mileage I would say roughly that the results today indicate at least double the belt mileage over the average of cars with the other."

Mr. Shirk: "The experience on the Great Western with axle pulleys on body hung machines is just opposite to the experience as stated by the various gentlemen who have spoken. The Great Western uses an eight-inch face axle pulley and we have at the Kansas City terminal a track termed the balloon track, where all trains are turned. I have watched that place for days and weeks, both Pullman equipment and the equipment of nearly all the railroads, and the successful lining up of the pulleys on that curve, I find the smaller pulley, the eight-inch face pulley gives a much better riding for the belt than the wider pulleys, in fact, we have 26 Pullman cars on the Chicago Great Western Railroad on which the Chicago Great Western Railroad furnishes the axle equipments. Invariably when our cars go to the Pullman shops, the Pullman people will put on one of their standard pulleys and when the car comes back to our line we immediately take it off and put on an eight-inch pulley. Gentlemen, the secret of belt life is slow speed generators and large pulleys."

Mr. Voight (Santa Fe): "We are still old fashioned on the Santa Fe. Now, I noticed the figures that Mr. Lunn quoted. There are so many factors that enter into belt life that the figures given by one road would not be comparable with those given by another. Without including the Pullman cars the mileage we report is 58,000 miles on an average for a belt. The average mileage of the Santa Fe cars is 86,000 miles and individual belts running up into 100,000, 130,000, and various mileages, which gives you a high average mileage. It is my experience that clearance, alinement and generator suspension, upkeep and belt tension, pulley ratios and other factors, such as Mr. Shirk has mentioned, enter very largely into the question of belt life, together with the everlasting question that we will have before us, and that is the proper belt clamp."

Mr. Lunn: "Mr. Shirk mentioned the fact that we can get better results with a slow speed generator. I agree with him. I would be glad to go to the slow speed generator if it did not cost us money. How would we handle the 7,000 or more old equipments that we have got and that we do not feel exactly like scrapping?"

Mr. Shirk: "Mr. Chairman, I think in solving the problem of taking care of our present high speed generators for an economical belt life we must come to building a rubber belt having a higher degree of lateral rigidity, that is, build a six ply belt and make it narrower, say a four-inch six ply belt. A four-inch six ply belt will give you a thicker belt, which will permit you to use a longer belt rivet with less cutting of holes and will give you a stronger belt right at the clamp, which I think will greatly help to solve the problem of belt clamps. That I think is the solution for the operation of high speed generators as long as they last."

Mr. Macnab: "Another point that enters indirectly into this problem is the question of generator suspension pins. We have had considerable trouble due to the suspension pins freezing, due to dirt and rust forming on the pins. Of course, probably some of you will say, 'Why don't you oil your pins'? Well, we do, as far as possible, but you all know cars get switched from one road to another, we have a 13,000 mile road, they get switched from one end to the other and it is pretty difficult to put your finger on the man that is responsible for not lubricating the suspension pins. The result is that once the oil holes get clogged you can pour all the oil you like into them and it will never reach the surface it is supposed to lubricate."

Mr. Shirk: "I would suggest that the gentleman from the Canadian Pacific try a mixture of white lead and signal oil and see that your pin is at least a sixty-fourth or thirty-second smaller than the bushing hole. Paint that pin with a mixture of white lead and signal oil and also put plenty of signal oil and lead in your bushing, and you will eliminate the oiling of your shafts and the wear on your shafts."

Electric Welding Report

The report of the Committee on Electric Welding was read by H. R. Pennington of the Rock Island Lines, chairman of the committee. In presenting the report, Mr. Pennington said: "The committee was not able to get together as much as we would have liked to. We have done the best we could under the circumstances. It was suggested by a number that some effort be made at least to draw up a working basis for a specification on welding equipment, and at the present time there seems to be no standard basis of rating machines among the different manufacturers."

The President: "I would like to ask anyone present who has had much experience with the alternating current welding machine and the direct current machine to give us the benefit of his experience with the two types of machine."

Mr. Macnab: "Mr. President, we have them located

on eastern lines at two or three of our largest roundhouses, and they have done all kinds of boiler repairs and boiler work and the building of engine frames, the general routine of welding work. One of the greatest disadvantages to the alternating current welding machine set is the difficulty of getting your a. c. supply of current and keeping the voltage constant. Where you have, as we have, automatic control air compressors that start and stop, sometimes once in two minutes, sometimes once in one minute, you never know when they are going to start and your voltage lets go and your arc is broken. There seems to be an opinion that possibly on account of drawing a smaller arc with the a. c. welder that it is not possible to burn the metal with the a. c. so much as you do with the d. c., but on our road there is a very strong and favorable opinion toward the one man d. c. equipment. We have a lot of one man d. c. equipment on the road as well as the a. c."

Mr. Marshall: "I would like to ask if anyone has any experience or observation on the use of alternating electric welders in regard to the safety of the operator. I have been told that they are a very dangerous thing when the operator stands beside the oil tank or somewhere where he is very naturally grounded."

Mr. Carlson: "We have done various classes of work, general routine work, with the a. c. machines in the enginehouses where they are located, but I can't say that we favor them on all classes of work. The operators who have been broken in and who have operated the direct current machines are lost for some time when you put them on an a. c. machine owing, as you all know, due to the different characteristics of alternating current. The d. c. machines, however, are very successful. As to the operator getting a severe shock off the a. c. machines, up to the present time we have had no serious cases of that nature."

FRIDAY SESSION

Electric Headlight Report

The report of the Headlight Committee was read by L. C. Muelheim, chairman of the committee, who said: "The report of the Headlight Committee to this convention is substantially the same as the progress report presented at the Atlantic City convention with the addition of two or three items, the more important of which perhaps is the recommendation that as a part of the Headlight Committee's work for the ensuing year there should be included something along the line of a standard, detailed method of procedure for the photometering of headlight reflectors."

Mr. Sloan: "On page 356, second column, the report reads: 'The replacing of metal reflectors by the glass type, as the former become unfit for service, is therefore recommended, as well as the adoption of the glass reflector in connection with the purchase of new equipment.' Recommendation No. 10 says: 'Adoption of glass reflectors for replacing worn out metal reflectors and for purchase of new equipment.' I would move that those two sections be eliminated from the report. I am fully convinced myself that the glass reflector will give the desired results. As I understand it, the reason for including these sections in the report was that trouble had been experienced with metal reflectors on account of the silver tarnishing, and for that reason the metal reflectors deteriorate very rapidly and require considerable labor to keep them in shape, and that labor then as the result of polishing them, removes the silver deposit and in a short time, after a number of polishes, the reflector had to be returned to be resilvered. I understand there have been recent developments where that silver reflector can be kept in shape for such a length of time that that objection has practically disappeared."

Mr. Muelheim: "Mr. Chairman, if the recommendations are objectionable to the members of the association I am sure that the committee will be quite willing to have them eliminated from the report."

Mr. Marshall: "I second the motion."

Vice-President Macnab: "Well, gentlemen, it has been moved and seconded that these two paragraphs be deleted from the report. All those in favor say 'aye,' contrary, 'no.' It is carried."

Mr. Marshall: "Mr. Chairman, in regard to ball bearings, a number of years ago we started to have ball bearings reground, and at first we thought that our experience was very good. Since that time, however, we concluded to discontinue the practice owing to the fact that very many times when ball bearings were removed it was due mainly to the fact that the outer race turned in its housing or the inner race was loose and turned on the shaft, that wearing either the housing or the shaft so that the reground bearings would not fit. I would like to ask if any of the members here have had a similar experience or whether they continue to have the bearings reground."

Mr. Hack: "I would say that we are having our ball bearings reground, but we first carefully test the bearing before we send it to the regrinding company and those that have undue wear we naturally scrap."

Mr. Muelheim: "I might say our experience is virtually the same as Mr. Hack's. Our bearings are collected at one central point and they are checked up very carefully for size. If they are found to be undersize or oversize they are rejected before they are sent in, and we find the regrinding service to be very satisfactory."

Mr. Hagensick: "We tried a few reground. The stores department sent back a number of bearings to be reground and we had quite a bit of trouble with those bearings, but it may have been due to a lack of inspection before they were sent. It is a good suggestion, I think."

Mr. Hack: "I will say we had the same thing, but we took it out of the stores department's hands and we, ourselves, check up the bearings before they are sent back. When the stores department attended to them they sent back bearings which were not fit to be ground."

S. D. Diamond (Soo Line): "My understanding is that those people who do the regrinding merely exchange bearings. They do not send back the bearings that are sent in."

Mr. Morrison (Ahberg Bearing Co.): "Would it be permissible for me to make a little statement in behalf of the reground bearings?"

Vice-President Macnab: "Certainly."

Mr. Morrison: "First, let me say that all the railroad bearings that we get for regrinding are returned to the party giving us the material. We have no stock of railroad special bearings to exchange. The bearings today are gaged to determine the exactness of the inside

diameter. If any of them are unfit for regrinding they are absolutely rejected."

MR. SHIRK: "I would say in regard to these regrinding bearings that we have had lots of shipments come back tagged or marked undersize and unfit for repair."

MR. LUNN: "Mr. Chairman, the ball bearings are marked to indicate the date on which they were made. I do not know whether it is the practice of the manufacturers to furnish a key to that marking, but it seems to me that we are overlooking an opportunity to get a good line on the average life of ball bearings if we fail to request the regrinding companies to report back to us the marking on those bearings so that we can check them up with the manufacturers."

MR. CARLSON: "While this bearing problem is up there is another question that enters into this ball bearing matter and I would like to hear from some of the members of the association on roads other than the New York Central as to what they do with the casing or part of the turbine casting in which the ball bearing is fitted, when it has worn to such an extent that they can no longer use the ball bearing casing in that casting."

MR. MUELHEIM: "Mr. Chairman, I might reply to the gentleman from the New York Central that we have been making a practice of bushing our housings for two or three years and find it very satisfactory when properly done."

MR. CARLSON: "I would like to ask this gentleman what the approximate cost is of boring a bushing?"

MR. MCGINNESS (Pyle National): "There is no reason why that portion of machines cannot and should not be rebushed if found necessary. The cost of it depends on how the work is done and the quantity going through at a time. We have a flat rate and for the machines that are generally in use; it ranges on the turbine cover about $3 and to the frame about $2.65."

VICE-PRESIDENT MACNAB: "There is one suggestion made here on the top of page 357 relative to the interchangeability of glass reflectors and cast iron cases. I think we ought to have some discussion on that. I think it would be worth while to hear from some of the members on that subject. That is a fairly wide proposition. We get into two or three or four different makes of glass reflectors, all of which won't interchange in the various types of headlight cases. The glass reflector proposition looks to me to be on the way to a mix up in a couple of years."

MR. SLOAN: "My idea is, Mr. Chairman, that we might eventually standardize on glass reflectors, but I think the present time is premature. I certainly think that it would be advisable to go ahead and standardize on some sort of a holder or headlight case that could take these glass reflectors."

MR. MUELHEIM: "Mr. Chairman, in making this recommendation for the adoption of glass reflectors the committee was not unmindful of the desire or the preference of some of the railroads to continue the use of the metal reflector to at least wear out their present sheet metal casings and in order to get the best results or the prolonged life of metal casings it can be very nicely done by using the means that one of the manufacturers has brought out in the adapting of an airtight reflector unit. This has given very good results on a number of the railroads and undoubtedly has great merit."

Insulated Wires and Cables

The final report of the convention was that of the Sponsor Committee on Insulated Wire and Cables of the American Engineering Standards Committee. Mr. Sloan read the report and then said: "Mr. Chairman, Mr. F. J. White of the Okonite Company is with us as one of the five original members of the Steering Committee and he is now secretary of the Sectional Committee and I think he could give more information if it is your desire, and more fully than I could."

VICE-PRESIDENT MACNAB: "Mr. White we would be glad to hear from you."

MR. WHITE: "Mr. Chairman, Mr. Sloan's report is very complete and gives a very good idea of the scope of this work. It has grown as the weeks and months have gone by until now we have on the Sectional Committee and on the twelve technical committees approximately one hundred and thirty engineers from all interests using insulated wires and cables. It is the desire of this committee to have as broad a representation as possible and to get the widest viewpoint possible. For that reason nominations were requested from all the different societies, your own included, for men on these technical committees. Now, the technical committees act as technical advisers to the Sectional Committee and it is very desirable to all of you men if you are interested in wires and cables to keep in touch with your own representatives in this work so that they are fully informed as to what your needs and desires are as affecting your work."

VICE-PRESIDENT MACNAB: "Is there any further discussion? The next business is a moving picture showing the complete process of the manufacture of Okonite insulated wire. I understand Mr. White is responsible for the moving picture and I will call on Mr. White."

In closing the convention after the showing of the picture, the president said: "I want to thank the committees who gave a great deal of their time and went to considerable trouble to work up these reports for us and also the officers and the Executive Committee for the active support that they gave."

Election of Officers

The officers elected for the ensuing year are as follows: E. S. Macnab, Canadian Pacific, president; Ernest Lunn, Pullman Company, first vice-president; F. J. Hill, Michigan Central, second vice-president. Two new members of the executive committee were selected as follows: E. H. Hagensick, Union Pacific, and George W. Bebout, C. & O.

Entertainment

The entertainment program arranged for the ladies who attended the convention consisted of a number of afternoon theatre parties. Informal dances were held each evening in the convention hall and on the final evening a dinner dance was held in the same room. All of the entertainment features were well attended and this part of the program materially aided in making the 13th annual convention one of the best that the association has ever held.

Carrara marble, from the famous quarries in Italy, has been excavated regularly for a period extending over 2,000 years.

R. E. S. M. A. Have Excellent Exhibit at Convention

Electrical Men Show Much Interest in Latest Developments and Keep Exhibitors Busy

THE exhibit of the Railway Electrical Supply Manufacturers' Association, which is always held in conjunction with the convention of the electrical engineers, was highly successful. There were a number of new exhibitors. All of the exhibition space was taken up, and if the number of exhibitors increases further either larger quarters will have to be secured or some of the larger companies will be obliged to give up part of their space.

Election of Officers

At the meeting of the supply men held on Thursday afternoon, November 2, the following officers were elected for the coming year:

President, Daniel Woodhead, D. Woodhead Corporation, Chicago; senior vice-president, R. L. McClellan, Westinghouse Electric and Manufacturing Company, New York; junior vice-president, George C. Scott, Safety Car Heating and Lighting Company, Chicago; treasurer, Ed Wray, Railway Purchases and Stores, Chicago; secretary, J. Scribner, General Electric Company, Chicago.

List of Exhibitors

Following is a list of exhibitors, alphabetically arranged, together with the various products on display and representatives of the several companies:

Albert and J. M. Anderson Manufacturing Company, Boston, Mass.—Complete line of charging plugs and receptacles for yard charging plants and car equipment; line of plugs and receptacles for arc-welding distribution both for d. c. and a. c., including double, triple and four pole types; line of plugs and receptacles for headlighting; line of time switches for control of suburban station lighting, floodlight and pumps.—Represented by B. G. Durham, Chicago.

Allen Bradley Company, Milwaukee, Wis.—Exhibit included a turntable controller for either one or two, slip-ring motors; a battery charging panel type L-1210 with an overload and underload protection; a cross-line starting switch for a. c. motor from 1 to 7 hp. including a no-voltage and overload protection; and a magnetic blow-out, the device being controlled manually or by remote control push buttons. Represented by F. L. Gohl, Chicago.

The Ahlberg Bearing Company, Chicago.—This exhibit consisted of a complete line of ball bearings for headlight generators, axle light generators, etc. This company also exhibited numerous oversize bearings as used in reground races. A special machine was used to demonstrate the accuracy of the ground ball bearings. Represented by D. A. Campbell, B. B. Clark, H. E. Dunning, K. R. Morrison, R. E. Bender, Chicago.

Appleton Electric Company, Chicago.—Exhibit consisted of "Unilet," pressed steel conduit fittings, outlet boxes, vapor proof switch boxes and fittings, together with a line of "Reelite" extension cord lighting units. Represented by A. I. Appleton, A. S. Merrill, D. V. Welling, E. A. Hokanson, Chicago.

Benjamin Electric Manufacturing Company, Chicago.—Exhibited a line of headlight sockets, water-tight attachment plugs and lighting fixtures, porcelain enameled steel reflectors, and a cast-iron hood railroad type reflector with screw thread. Various styles of lighting panels, and a new feed-through fuse box and a weatherproof telescope relay for industrial signal horns. Represented by W. J. Goodrich and R. C. Mons, Chicago.

Bryant Electric Company, Bridgeport, Conn.—This company exhibited a hospital signal station with special pull control, operated on 110-volts; a complete line of sockets, receptacles, plugs, cartridge cutouts and interconnecting blocks; watertight and non-watertight plugs and receptacles; dead front panel switches with connections for plug fuses and cartridge fuses; dead front cutout blocks, and panel switches, conduit fittings and a line of threaded cap sockets; also "Flexits" bull's-eye and heater control combinations. Represented by W. O. Dahlstrom, Ward Thomas, Val B. Habryl and Clyde Foster, Chicago.

The Buda Company, Harvey, Ill.—This company exhibited two headlight turbo-generators, one of ½ kw. capacity and the other a 1 kw. capacity. A new patented ball-bearing mounting on the turbine wheel in a moisture-proof housing was a feature of the exhibit. Represented by H. P. Bayley, Harvey, Ill.

Central Electric Company, Chicago.—Line of "Ralco" plugs and receptacles for battery charging and power service for use in shops, yards, power stations, locomotive and car wiring; "Okonite" wires and cables; "Okonite" and "Manson" tape; "Maxolite" reflectors and sockets; Four-In-One light fixtures for station and office lighting; D. & W. renewable fuses; Deltabeston wire for armature winding, heater cords and asbestos-covered products; flexible hose armor, ⅜ in. to ½ in., for locomotive and car wiring, also car fans. Represented by J. M. Lorenz, R. N. Baker, A. L. McNeill, L. R. Mann and E. H. McNeill, of Chicago. Okonite representatives, D. U. Underhill and F. J. White, of New York.

Chicago Fuse Manufacturing Company, Chicago.—An extensive display of enclosed fuses, all types and sizes, refillable and non-refillable; outlet boxes and switch receptacles. Represented by H. P. Collins and T. C. Walsh, Chicago.

Crouse-Hinds Company, Syracuse, N. Y.—This exhibit included condulets for all departments of railway service, such as headlight switches, safety switches, cab-wiring devices, coach and dining car equipments, etc. Also floodlight projectors, roundhouse reflectors, car wiring panels and a complete line of plugs and receptacles. Represented by F. F. Skeel, Charles Dubsky, N. E. Bigely, Chicago, Ill.; A. E. Vieau, Minneapolis, Minn.; J. B. Wilmott, St. Louis, Mo.; H. J. Mac-

Intyre, New York; A. B. McCheseney, Detroit, Mich.; D. A. Nesbitt, Cleveland, Ohio; A. B. Coffman, Philadelphia, Pa., and E. G. Smith, C. H. Bissell, F. J. Fancher, of Syracuse, N. Y.

Cutter Electric and Manufacturing Company, Philadelphia.—This company exhibited U-re-lite circuit breakers for both a. c. and d. c. circuits. The d. c. line for up to 250 volts included; the junior for capacities up to 60 amp. and the senior for up to 200 amp., the type-W for up to 400 amp., and the N.X. for up to 1,250 amp. The a. c. line for voltages up to 550 volts, 3-phase included; the auto-senior for up to 150 amp., the type W up to 400 amp. Represented by Swift Newton, D. M. Bercow and I. S. Allen.

Edison Storage Battery Company, Orange, N. J.—This company exhibited Edison nickel-iron car lighting batteries. A portion of the cells were cut away to show all the structural details. A miniature storage battery propelled coach also was on exhibit. Represented by D. C. Wilson, Orange, N. J.; William Coleman, New York; W. F. Bauer, A. M. Anderson, A. S. Knox, Chicago, and R. C. Haley, St. Louis, Mo.

Electric Storage Battery Company, Philadelphia, Pa.—Exhibit included a car lighting generator in operation in connection with an Exide car lighting battery; a demonstration was made of the methods of suspending the generator from a car body; a special feature of the exhibit was a Manchester positive group from a cell that has been in car lighting service for 10 years, covering over 1,678,250 car miles; this battery was installed with the first E. S. B. constant potential equipment. A new device was demonstrated consisting of a float to indicate the level of the acid in the cells, thus avoiding the necessity of pulling out the crates to ascertain the acid level. Represented by H. B. Marshal, New York; W. W. Woodbridge, Philadelphia; R. I. Baird, T. Milton, O. R. Shutall, H. E. Kirby, Chicago, and H. B. Hamilton, Cincinnati.

Electric Service Supplies Company, Philadelphia, Chicago, New York.—Exhibited a complete line of locomotive headlighting equipment, with "Golden Glow" headlights and Keystone turbo-generators; locomotive headlight switches, lamp guards, gage light fixtures, roundhouse lighting units, etc. There were also exhibited Segur coil machine, armature band wire tension machine and Acme commutator smoothing machine. Besides exhibiting standard and sectioned models of Keystone turbo-generators, an interesting operating model showing the lubricating system was on display; this showed in an interesting manner the method employed for carrying oil from the main reservoir to all bearings, including those of the governor mechanism. The line of headlight bodies included heavy gage sheet metal and cast metal types with special features of quick renewals of glass number plates, dirtproof gaskets, etc. Represented by T. M. Childs, J. R. McFarlin, L. A. Darling, H. G. Graham, A. H. Kopprasch, Philadelphia, and B. D. Barger, J. W. Porter, Chicago.

Fairbanks, Morse & Co., Chicago.—Exhibited a sectionalized squirrel cage a. c. induction motor with ball bearings; demonstrating the balance and ease of starting by a string belt connected to a fan which received its power by a blast from an electric fan. The exhibit included several rotor cages with cast-on ends and ball-bearing assemblies. Represented by M. O. Southworth, F. M. Condit, James Dandie, A. A. Taylor, G. W. Lewis and B. J. Spaulding, of Chicago, and H. E. Vagel, of Baltimore.

General Electric Company, Schenectady, N. Y.—This company had no apparatus on exhibit, but was represented by John Roberts, C. C. Barley, F. P. Jones, Jr., Robert Hughes, Carl Darticos, William B. Brady, G. L. Brol and G. L. Wiler.

B. F. Goodrich Rubber Company, Akron, Ohio.—Exhibit included composition rubber battery jars for train lighting, mine locomotives and vehicles; one-piece battery containers; perforated sheet separators and moulded separators; hard-rubber rods and tube insulation; insulating footwear and axle lighting belting. Represented by E. A. Bedell and C. D. Raff.

Gould Coupler Company, New York.—This company exhibited adapter body type suspension, Type B. B.-9-B generator regulator; type AB-9-B combination generator and lamp regulator; type M-2 lamp regulator; a full working set direct drive for car lighting generator; a turbo-generator for locomotive headlight (500-watt 32-volt a. c.); double compartment unit, set up with chemically pure plated wood separators rubberized. Represented by W. F. Bouche, M. R. Shedd, of Depew, N. Y.; P. H. Simpson, New York; G. R. Berger, of Chicago.

Harter Manufacturing Company, Chicago.—This company exhibited a new line of adjustable lamp sockets and reflectors, for use in railroad and industrial lighting. Represented by G. A. Harter, R. O. Williams, F. F. Pickhardt and A. C. Larson, Chicago.

Industrial Controller Company, Milwaukee, Wis.—Exhibited an automatic starter for a 15 hp. 3-phase 220-volt slip-ring motor; an automatic compensator for a 15 hp. 220-volt 3-phase motor and a cross-line type automatic starter for motors from 1½ to 5 hp.; a 150-amp, d. c. contactor; a hand compensator and push button stops and starters. Represented by E. J. Rooker, Chicago, and John McC. Price, Milwaukee, Wis.

Ivanhoe Regent Works of General Electric Company, Cleveland, Ohio.—Exhibit included a complete line of reflectors and holders for industrial and railroad shop yard and platform lighting for both indoor and outdoor service. Represented by G. W. Beales and C. R. Stover, Cleveland, Ohio.

The Kerite Insulated Wire and Cable Company, Inc., New York.—Exhibited samples of power cable, charging cable, headlight wire with special braid finish, building and car wire, plain battery connector cable and ignition wire. Represented by Azel Ames and P. W. Miller, of New York; E. L. Adams, J. A. Hamilton, W. H. Fenley and C. A. Rebb, of Chicago.

Loeffelholz Company, Milwaukee, Wis.—This company exhibited a complete line of the "Gibbs" train line connectors, receptacles, hooks and hangers. Represented by George B. Miller, Milwaukee, Wis.

Lucey Manufacturing Corporation, Houston, Texas, and New York.—This exhibit included a 32-volt, 3-kw. "Turbolite" generator for headend train lighting, a 750-watt headlight turbo-generator and a complete line of cast metal headlight cases. Represented by B. B. Lacey, manager of Turbolite Division, Houston, Texas.

Main Belting Company, Philadelphia.—This company had on exhibit a complete line of car lighting belts, together with a new patented flexible belt fastener. Represented by H. W. Lyndall, Philadelphia, Pa.

National Lamp Works of General Electric Company, Cleveland, Ohio.—Exhibit included the largest incandescent lamp in the world, using 30 kilo-watts producing approximately 100,000 spherical candle power, the bulb being 12 in. in diameter, along side of which was a tiny lamp only 1/16 in. in diameter, using only 3 amp. at 1.5 volts. A demonstration was given to show the effect of varying intensity and direction of illumination on the speed and efficiency of the vision. Numerous train lighting and car lighting bulbs, together with a portable foot candle meter, were also exhibited. Represented by C. W. Bender, C. R. Stover and M. E. Glass.

Oliver Electric and Manufacturing Company, St. Louis, Mo.—Exhibit included locomotive headlight switches, toggle switches, terminal boxes, junction boxes, plugs and receptacles, flexible conduit couplings, car lighting fixtures; tender signal lamps, plugs and receptacles for shop wiring, marker and classification lamps; also portable hand lamps for extension circuits. Represented by J. A. Amos, W. M. Graves, Jr., Charles Gelan and W. A. Ross, St. Louis, Mo.

Pyle-National Company, Chicago. — This company showed a complete line of non-corrosive cast metal and sheet metal headlight cases equipped with non-glare glass reflectors; a line of turbo-generators, as follows: 10-kw. for train lighting, type B 500-watt headlight generator, type A 500-watt a. c. high frequency generator, and a type K-2 d. c. 500-watt headlight generator; also a line of floodlights, backlamps, and a line of automatic line connectors and pilot house control for search lamps. Represented by R. L. Kilker, Atlanta, Ga.; J. L. Reese and Robert Shaal, New York; George Hass, William Miller and J. Will Johnson, Charles W. Dake, Chicago, and Roger Lucy, Sidney, Australia.

S. K. F. Industries, Inc., New York.—This company exhibited a line of ball bearings for car lighting and headlighting machines; a new line bracket and pillar lineshaft bearings equipped with self-centering ball bearings; and also a new self-centering roller bearing. Represented by W. L. Batt, New York; W. B. Pusey, Milwaukee, Wis.; A. Alvin, Minneapolis, Minn.; William Jetter, Philadelphia, Pa.

Safety Car Heating and Lighting Company, New York. —This company exhibited the Putnam storage battery, axle-drive generators, regulators, electric water heaters and coolers; exhaust fans, ceiling fans and bracket fans, lamps, reflectors, shades and fixtures for car lighting. Represented by J. H. Rodger, George E. Hulse, I. I. Hopkins, George H. Scott, Carl Pinyard, H. K. Williams, J. H. Marsh and R. S. Gay.

Square D Company, Detroit, Mich.—Exhibit included the new line of 8600 series enclosed safety switches of 30- 60- and 200-ampere capacity made on the unit base construction with a quick make and break feature and incorporating the special cover control. Represented by H. E. Fritschle and H. A. McDonald.

Railway Electrical Engineer, New York.—At this booth were exhibited copies of the *Railway Electrical Engineer,* together with a large display showing the samples of articles published from time to time on railroad train lighting, head-lighting, shop motors, illumination, electric welding and heavy electric traction. Represented by A. G. Oehler, C. J. Corse, H. B. Bolander, R. F. Duysters, New York; B. J. Wilson, J. M. Rutherford and J. H. Dunn, Chicago, and E. A. Lundy, Cleveland

U. S. Light & Heat Corporation, Niagara Falls, N. Y.—This company exhibited various types of car lighting regulating apparatus, including the ampere hour meter, also a small baggage car and coach equipment, including complete regulating apparatus. A 1½-kw. body-hung generator was shown. A portable arc-welding machine of 200 amp. capacity a. c.-d. c., with special weather-proof features, was shown, together with samples of arc-welding work. Represented by H. A. Mathews and Ernest Bauer, Niagara Falls, N. Y.; A. W. Donop and H. A. Morrison, Chicago, and O. R. Hilderbrant, Washington, D. C.

United States Rubber Company.—Exhibited hard-rubber battery jars for car lighting for either 13 or 15 plate capacities; battery liners and separators insulated wire and tape; axle belting; insulated wire and glove, boots, etc. Represented by L. S. Hungerford, Jr., and G. M. Haynes.

Western Electric Company, New York.—Displayed the W. E. railroad flood lighting lamp and portable utility light for railroad use; also Sunbeam lamps for all purposes; electro-magnetic drilling machines; Benjamin steel reflectors and glass lighting units. Habershaw products were also exhibited, including Habirlite locomotive headlight wire and cable light cord, railway signal wire, sector and concentric power cables and submarine cables. Western Electric representatives were George Hull Porter, E. W. Kearns, T. J. Rider, O. B. Duncan and H. C. Olmstead, Chicago; J. Carmen, Omaha, Neb.; R. Eves, Baltimore, Md.; P. Hansen, Minneapolis, Minn.

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.—Exhibit included a portable arc-welding motor generator set; industrial type electrical heating furnace; electrical solder pot and a motor-starting switch for 10-hp. motors. Represented by W. W. Reddie, A. M. Candy, W. A. Furst, Q. W. Hershey, G. T. Keech and L. A. Spangler.

Daniel Woodhead Company, Chicago.—Diehl railway electric fans including a new adjustable oscillating fan; Wheeler reflectors; exhibit also included Candee tape, Ackerman tape, non-fluid oil and commercial lighting units; a special test for tape was on demonstration. Represented by Stuart Standish, New York, of the Woodhead Company, M. W. Buchanan, Diehl Mfg. Co., and W. C. Candee, New York, of the Ackurite Rubber Company.

Sunbeam Electric Manufacturing Company, Evansville, Ind.—This company exhibited a turbo-generator and locomotive headlight together with various parts of this apparatus. Represented by J. Henry Schroeder, of Evansville, Ind.; W. T. Manogue, New York; and H. A. Varney, of Chicago.

Howell Electric Motor Company, Howell, Mich.—Exhibit included a line of Howell "Red Band" polyphase

motors demonstrating the patented rotor recentering bearing, also a special line of double cotton covered wire. Represented by D. A. Reed, J. M. Johnson and D. S. Wilkus, Howell, Mich.

Thompson Electric Company, Cleveland, Ohio.—This company exhibited a new type of safety cutout hanger for hanging large industrial lamps in shops, roundhouses, yards and also for depot lighting. Represented by A. J. Thompson, Cleveland, Ohio.

Stone Franklin Company, Inc., New York.—This company exhibited an automatic controller panel for a single battery stone Franklin car lighting equipment. Represented by H. D. Rohman and J. L. Hayes, New York; W. L. Gray and R. Girard, Montreal; R. E. Gallagher, St. Louis.

R. Thomas & Sons Company, East Liverpool, O.—Exhibited low voltage and high tension line insulators, pins, strain clamps, eye bolts, insulators for third rail, cable racks and porcelain specialties. Represented by R. W. Harms, Chicago. H. R. Holmes and G. E. Eckert, East Liverpool, O.

Future Possibilities of Arc Welding

By B. C. Tracey

Power and Mining Engineering Department, General Electric Company

There is no doubt but that the method of joining metals with the aid of the electric arc is beyond the questionable stage. The success of the many applications to which it has been put, and the research and consulting activities of the American Welding Society have established it upon a firm footing as a practical industrial process.

So much has already been written, and discussion has been so rife regarding the present practice of arc welding that the writer has decided to confine this brief article to future possibilities. They are the result of a painstaking investigation, and are set forth in the hope that they will prove of assistance to those interested in getting work done at less expense, but without lowered effectiveness. It is always difficult to launch a new process, or even a new application of an established one, as conservation is a normal state of mind. For example, dire things were predicted a few years back, when the first complete locomotive fire box was welded with the electric arc. Today there are approximately 1500 of these boxes in use, and so far they have met with unqualified success.

Car Repair

A careful study of the freight car repair yards recently impressed the writer that a splendid field is open to the art of electric welding if it is carefully performed. Among the suggested new applications may be mentioned repairing broken side truck frames that have become defective within the guarantee, renewing patches in car sides, welding on hand rail columns, angle supports and various other applications in the repair yards.

Car Construction

In the construction of new cars the conservatism exercised in the past might well be set aside and more progressive thought be given to the following suggested applications, bearing in mind that they are new applications, and that time and study should be given to the stresses and strains to which each part is subjected.

Cylinder supports which now require the use of three ¾-in. rivets as well as the reservoir supports requiring one ¾-in. rivet could be welded to the center sill diaphragm.

Cross tie braces also offer a splendid field for arc welding. They can be welded at one end to the center sill, the other can be welded to the side sill. The three large center sill supports, also four of the small center sill supports which at present require nine ⅝-in. rivets could be welded to the center sill diaphragm.

The elimination of 19 ⅝-in. rivets could be accomplished in the welding of the cross bearer bottom cover plate. This would require an overhead operation for the operator but it has been established that an experienced operator can perform an overhead operation as easily as a vertical or a horizontal one.

The cross bearer diaphragm could be welded to the center sill and to the side sill, by making a small fillet weld to each sill, thereby eliminating six ⅝-in. rivets.

The bolster and supporter requiring six ¾-in. rivets and the bolster center supporter requiring four ¾-in. rivets, the end sheet stiffener requiring seven ⅝-in. rivets and six ¾-inch rivets could be welded to the center side cover plate and to the striking casting.

In the welding of the bolster top cover plate to bolster diaphragm it is the writer's recommendation that the width of the cover plate be made 1½ in. narrower than the outside dimensions of the diaphragm. This would make an easy operation for the operator and the space between the top cover plate and the bolster diaphragm could be taper welded by applying a fillet weld from the ⅝-in. to the 5/16 in. plate with the elimination of 52 ¾-in. rivets, as well as the savings in the steel.

The application of arc welding the center sill cover plate to the center sill offers another field to the automatic arc welder, which has recently been developed, making a fillet weld the entire length of the diaphragm and eliminating 188 ⅝-in. rivets.

The application of tack welding the top cross tie cover plate to the cross tie and fillet welding it to the center sill would create a saving in eliminating 28 ⅝-in. rivets.

The bottom cross tie cover plate at present is 3 in. wider than the cross tie diaphragm. It is recommended that the bottom cross tie cover plate be 1 in. wider than the cross tie diaphragm and that a fillet weld be applied the entire length, which now requires 18 rivets of ⅝-in. diameter.

The hand-brake rod support could be welded to the center sill by applying a fillet weld front and rear, which now requires four ¾-in. rivets.

The three lever guides, the floating lever fulcrum, as well as the bottom strap to fulcrum lever, could all be successfully arc welded to the center sill.

The diaphragm brace from center sill and bolster diaphragm to side and end sills could be welded, making a continuous fillet weld from the bolster diaphragm to center sill. The 12 side posts and 12 side braces, could be welded to the side sill and to the top angle that supports the roof. This would eliminate 192 ¾-in. rivets.

The writer believes that the three supports to the side sills could be butt welded from the outside. This now requires 72 ¾-in. rivets.

The side door threshold angle can be welded to the side sill. The threshold angle plate should be ¾-in. narrower than at present to enable making a flush weld to clear flooring. Welding bottom end sheet to end sill bottom angle would require a fillet weld the entire length and eliminate 22 ¾-in. rivets.

Instead of riveting the bottom end sheet to center sheet to top sheet, they could be successfully arc welded by making a weld both inside and outside at the lap joint.

The cardboard brackets to top and center end sheets, the grab iron to end ladder stiles, the brake mast guide to end sill, the pin lifter bracket to end sill and the side end sill corner gossets, all could be safely arc welded at a probable saving.

The top diagonal brace could be welded to the side sill and to the end sill; also the bottom end sheet could be welded to side plate to end sill. The top door track to side plate angle could be welded by applying a fillet weld the entire length of door track to side plate angle.

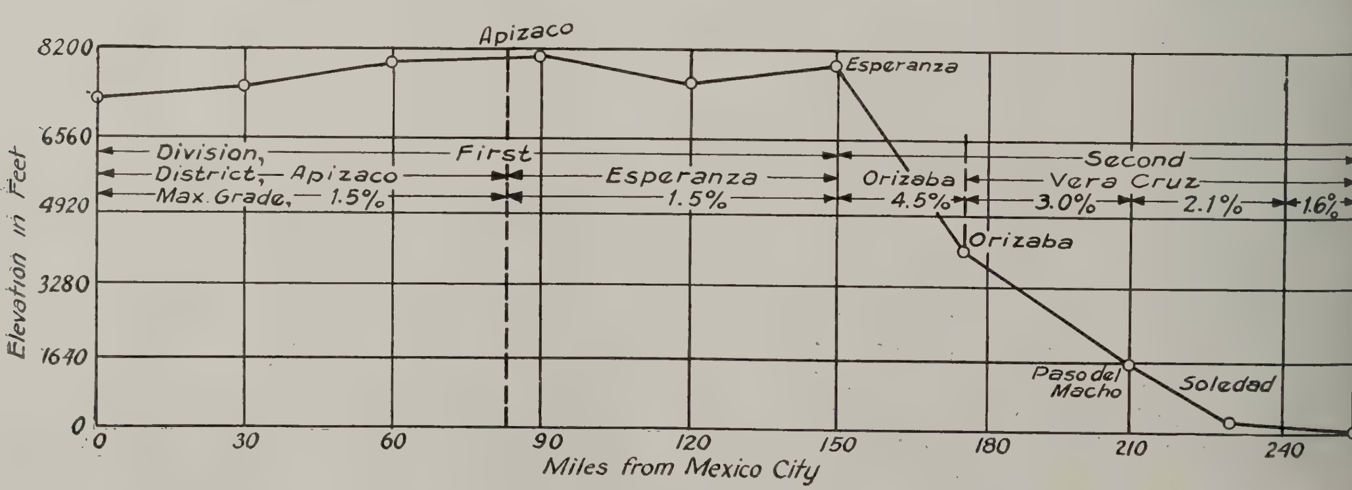
The two ridged pole supports to be welded to the end sheets as the well as the ridged pole plate to car lines and ends. The grab irons support to end sheets, the pipe clamp support to end sill angle, the sill steps to side sills, the car lines to top angle, the car lines to top side angles, the running board brackets to end sheets, the brake mast guide top to end sheet, and the brake mast steps to end sheet could all be successfully arc welded, each creating a saving in the elimination of rivets.

Mexican Railway to Electrify Thirty Miles of Main Line

The International General Electric Company has received an order from the Mexican Railway Company, Ltd., of Mexico City, for the electrification of 30 miles of single track between Orizaba and Esperanza, which is on the main line between Mexico City and Vera Cruz. The approximate cost of the electrification project will be between $2,000,000 and $2,500,000.

This is the first main line steam road electrification to be undertaken in Mexico and is on the oldest and one of the largest railways in the country. The compelling reasons for electrification were the heavy grades and increasing

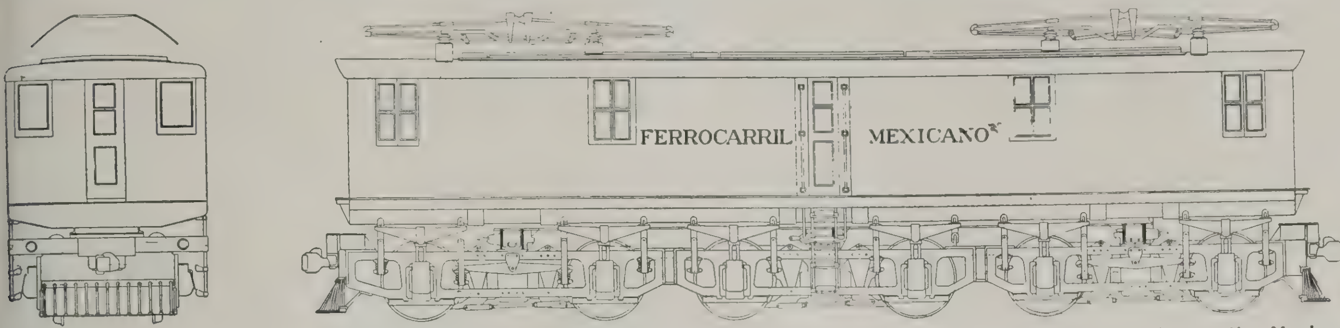
Map of the Mexican Railway. Initial Electrified Section Will Extend from Esperanza to Orizaba



Profile, Showing Divisions and Districts

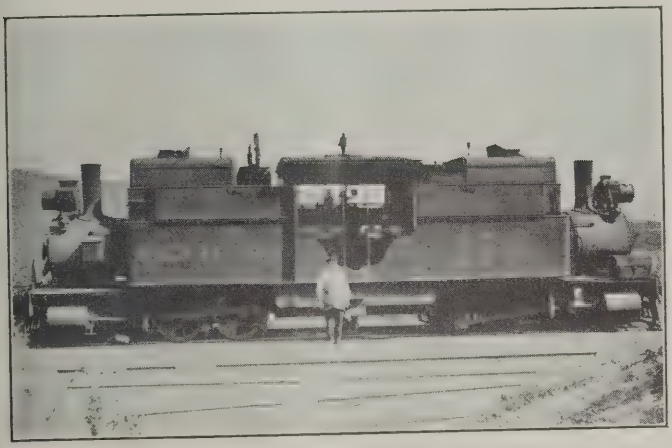
traffic. Indefinite postponement of the necessity for double tracking the road and a saving which will pay for the entire cost of electrification in five or six years is indicated. The system will be operated at 3,000-volt direct current, power to be supplied at this voltage by the Pueblo Tramway Light and Power Company, whose hydroelectric plant is five miles from Orizaba.

The electrification of this portion of the Mexican Railway is the beginning of the main line extensions which will follow as it becomes necessary to increase the capacity of the single track or the number of electric locomotives. The total route mileage of the Mexican Railway is 403 miles, rising from sea level at Vera Cruz to a maximum altitude of between 8,000 and 9,000 feet. Grades as steep as 5.25 per cent are encountered while the ruling grade on the electrified portion will be about 4.7 per cent.



End View and Side Elevation of 150-Ton, 3000-Volt Direct Current Type of Electric Locomotive to Be Put Into Service on the Mexican Railway

The International General Electric Company will supply ten 150-ton locomotives interchangeable for freight and passenger service, equipment for an automatic substation, the trolley overhead and feeder lines and fittings complete. It will also supervise the complete installation.



Double-Ended, Oil-Burning Steam Locomotive Which Will Be Supplanted by Electric Motive Power

The presence of abundant undeveloped hydraulic power, the permanent dependence on foreign coal, and the unfavorable economic situation of the country are factors which will undoubtedly continue for a long period to guide the French public policy and to encourage private initiative towards a greater utilization of electricity. Thus the interests of the State in reducing the unfavorable trade balance and of the individual in his efforts to obtain cheaper power are alike.

The French Government has not only given its moral support in favor of a more intensive use of electricity but has also aided materially by the construction of lines for the distribution of power. In fact the Government advocates the construction of such lines as may be necessary to connect the important centers of hydraulic production such as the Alps, the Pyrenees, Auvergne, the projected centers involving the harnessing up of the Rhone and Rhine Rivers and the tidal force in Brittany with the steam power centers of Paris, Lorraine, and Northern France.

Passenger Train Hauled by Two Double-Ended Steam Locomotives Ascending Grade North of La Bota

The Crossing at Hurricane Gulch, Alaska Railroad

French Railway Begins Electrification Program

Complete Steam Division To Be Electrified Will Furnish Interesting Comparison Between Steam and Electric Operation

By A. H. Candee and L. E. Lynde
Engineering Dept. and Railway Dept., Westinghouse Electric & Manufacturing Co.

AFTER a careful investigation into the subject of electrification, the railroads of France have decided to electrify over 5,000 miles of their tracks. This decision will enable them to increase the capacity of their present trackage, and will at the same time utilize some of France's tremendous waterpower available in the Alps, Pyrenees and other mountainous sections. A large amount of the coal used by the railroads is imported, which not only is costly but proves a serious handicap in time of war.

The following lines have all made definite plans toward electrification: The Paris, Lyons & Mediterranean running to Marseilles-Nice-Monte Carlo and into Italy, as well as into the Alps where heavy grades are encountered; the Midi operating in the southern part of France; and the Paris-Orleans.

The Paris-Orleans is taking the initial step in electrifying approximately 145 route miles including its main line extending from Paris to Vierzon. The trains of the Paris-Orleans leave Paris from Quai d'Orsay station, travel through one of the most densely populated sections of Paris, after which they head practically southwest for Orleans, a distance of about 75 miles. En route to Orleans, the road passes through Bretigny from which point a short branch line to Dourdan will be electrified.

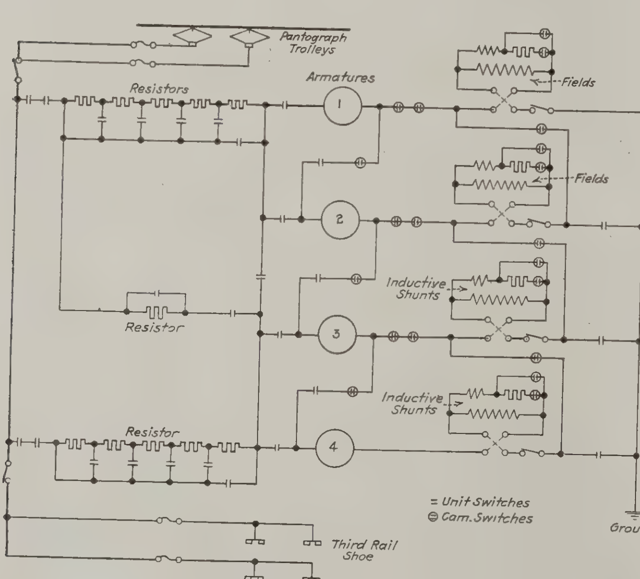


Fig. 1—Main Circuit Wiring Diagram

Orleans, a city of over 70,000 inhabitants, and located on the Loire River, is the terminal for a large number of lines. From Orleans the line runs by Nouan and Sabris in passing to Vierzon. Vierzon, which is approximately 125 miles from Paris, is the terminus of the steam engine division and it is this division which the Paris-Orleans is electrifying.

For operation over this zone and a future extension south of Vierzon, 200 locomotives will be purchased. The orders for the first 120 locomotives have already been placed with a group of French manufacturers, namely Compagnie Electro Mecanique — Societe Schneider—Forges et Ateliers de Construction Electriques de Jeumont—Compagnie Thompson Houston, each of whom will build a portion of the locomotives or equipment.

Each locomotive will rate approximately 1,400 horsepower for one hour and approximately 1,200 horsepower continuously, both ratings being at 1,350 volts direct current. A single box cab will be mounted on two 0-4-0 swivel trucks, the total weight of locomotive complete being approximately 60 metric tons or 66 U. S. tons. The mechanical parts, however, will be of sufficient strength to permit of ballasting to 72 metric tons or 79.35 U. S. tons, without any modification other than a change in springs.

The dimensions of each locomotive are given in Table I.

Table I
Locomotive Dimensions

Length between buffers	12.63 meters =	41 ft.	5	in.
Length of cab	11.10 meters =	36 ft.	3	in.
Width of cab	3.00 meters =	9 ft.	10	in.
Total wheel base	8.80 meters =	28 ft.	11	in.
Rigid wheel base	2.70 meters =	8 ft.	10	in.
Distance between truck center pins	6.10 meters =	10 ft.	0	in.
Diameter of new wheels	1.20 meters =	.. ft.	47¼	in.
Thickness of steel tires	.075 meters =	.. ft.	3	in.

The specified tractive efforts for these locomotives are given in Table II, these being with a gear ratio of 21 to 62 and wheels of 1.20 meters diameter (47¼ inches). Each axle will be driven by a series type, 1,500 volt four pole railway motor rated at 300 hp. continuously at 1,350 volts and 350 hp. for one hour at 1,350 volts.

Table II
Specified Continuous Tractive Efforts and Speeds

T. E.		Speeds			
Kg.	Lb.	Kmph.	Mph.		
7,080	15,600	10.3	6.4	Series connections	Full field.
5,520	12,200	13.8	8.6	Series connections	Min. field.
7,080	15,600	22.1	13.7	Series-parallel connections	Full field.
5,520	12,200	22.8	28.8	Series-parallel connections	Min. field.
7,080	15,600	45.8	28.4	Parallel connections	Full field.
5,520	12,200	59.2	36.8	Parallel connections	Min. field.

While the mechanical parts and all but a few of the motors for these 120 locomotives are to be manufactured by European concerns, the complete control equipment will be built by the Westinghouse Electric & Manufacturing Company at its plant at East Pittsburgh, Penna.

The locomotives are designed for double end control, multiple unit operation and are governed through a low voltage battery train line. Westinghouse type HBF electro-pneumatic control, which is now standard on many of the large roads in America, will be used, the main circuit diagram of which is shown in Fig. 1. As may be seen, the motors will be connected first in series, then in series-parallel and finally in parallel. Twelve series

notches, nine series-parallel notches, and nine parallel points will be provided. The last two notches of each combination are field control notches, the field strength being reduced by means of inductive shunts as shown. Variations in tractive effort from notch to notch must be kept very low on account of the limited strength of the car couplings. The circuits are arranged so that regenerative control and dynamic braking may be provided later with a minimum change, by adding the necessary equipment in space left for that purpose. None of the locomotives will be provided with regenerative control at present, but extensions to the south of Vierzon will be over profiles which will warrant the use of this feature.

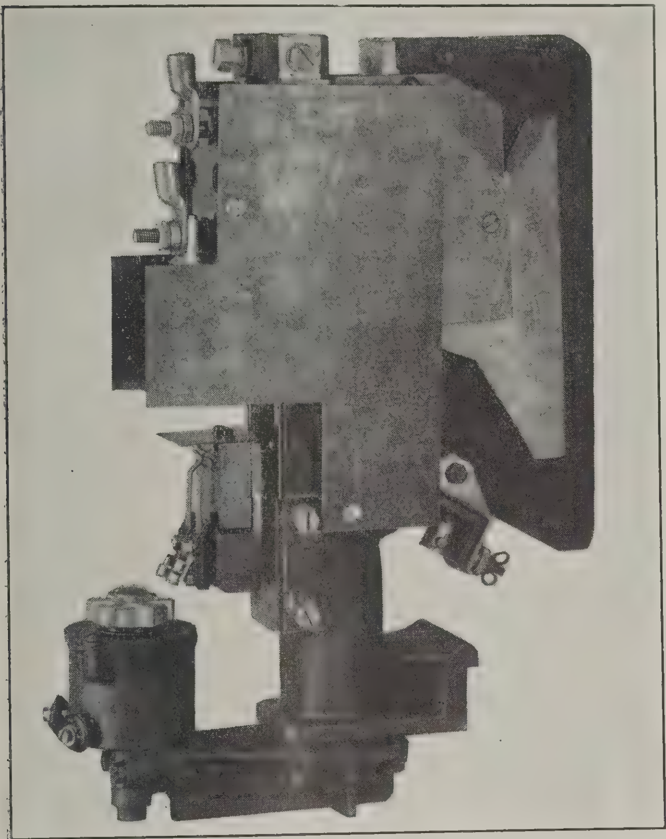


Fig. 2—One of the Electro-Pneumatic Unit Switches

Power is to be received either through third rail shoes or from overhead wire. It was the purpose at first to use a third rail along the entire length of line except at stations, crossings, yards, and similar points, but the idea has been modified so that the use of the overhead conductor will be considerably extended.

The pantagraph trolleys will be of the air raised gravity lowered type. A main knife switch will be provided for isolating the locomotive circuits from the trolleys and another will disconnect the circuits from the third rail shoes.

The main circuit connections will be made by means of unit switches and cam switch groups, each being operated by compressed air at 70 pounds pressure per square inch. Fig. 2 and Fig. 3 illustrate these items. Use is made of cam switch groups only where it is found desirable to provide a mechanical interlocking of switches and where the cam shaft can be arranged for two positions only. Where cam groups must have three or more operating positions, the difficulty of stopping the cam shaft on an intermediate position would introduce a complication in the control and reduces its factor of reliability. Unit switches are also preferable for arc-breaking service.

Overload protection is provided by the use of an overload relay for each individual motor circuit and also one for the main feed. A ribbon type fuse is placed in the circuit of each trolley and one fuse is placed on each side of the locomotive connected between the third rail shoes on that side and the main knife switch. Provision will be made for installing a high speed line switch at a later date, should this be found necessary in order to further protect the motors against flashing.

One master controller will be placed in each end of the locomotive, to the left of the locomotive center line, with the brake valve to the left of the controller. The controller handle extends to the left of the controller for operation with the right hand. This arrangement is to conform to the standard French system of running on the left hand tracks. Fig. 4 shows the master controller with the cover removed.

Each locomotive will be provided with two blowers for motor ventilation and two compressors. The blowers will be arranged so that the failure of either will not cut off ventilating air from the motors. Expulsion type fuses will be used to protect these circuits. The control battery will be charged in series with the blower and compressor motors by the use of a battery-charging resistor and relay.

Very complete and thorough tests will be made of the various items of equipment both before installation in the locomotive and after the locomotive is complete. Preliminary acceptance of each of the first ten locomotives will be given only after it has operated satisfactorily for a distance of 25,000 kilometers (15,500 miles). The balance of the locomotives will be given preliminary acceptance after operating satisfactorily for a distance of 3,000 kilometers (1,865 miles). Each break-down of more than four hours will extend the preliminary acceptance run by 1,000 kilometers (621 miles) for every two days or less that the locomotive is out of service due to defects. The preliminary acceptance for the first ten locomotives, however, will be given within three months after their delivery if the necessary mileages have not been covered by that time. Subsequent locomotives will be given preliminary acceptance at the end of one month if the necessary distance has not been covered within that time.

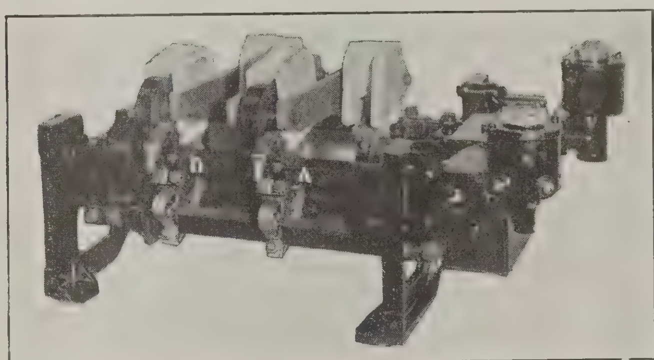


Fig. 3—One of the Cam Switch Groups Also Operated by Compressed Air

Final acceptance of each locomotive will be given one year from the date of preliminary acceptance providing the locomotive has operated a distance of 50,000 kilometers (31,000 miles). If the distance operated has been reduced on account of defective construction or design this final acceptance will be extended three months if the locomotive has operated more than 35,000 kilometers (21,700 miles) and six months if less than this distance. All dates, however, are based on very reasonable allowances, and afford the manufacturers every opportunity to fulfil their part of the contract with the minimum of hardship.

It is expected that the first of these locomotives will be in operation by October 1, 1923, and that the order will be completed by January 1, 1925. This averages approximately four locomotives delivered per month between these dates.

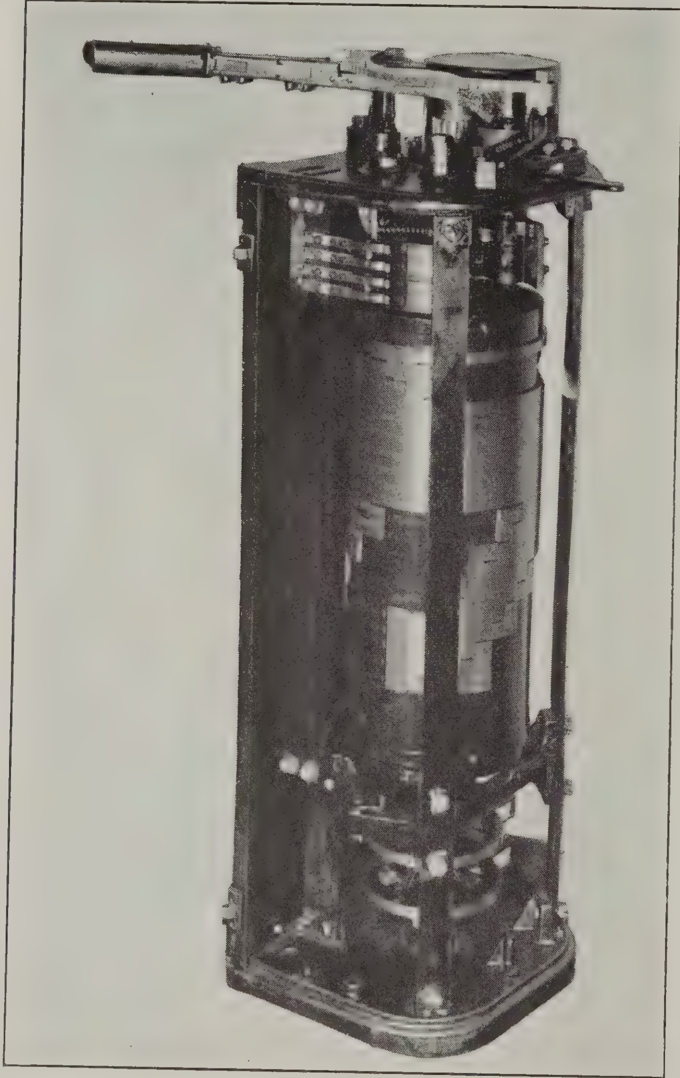


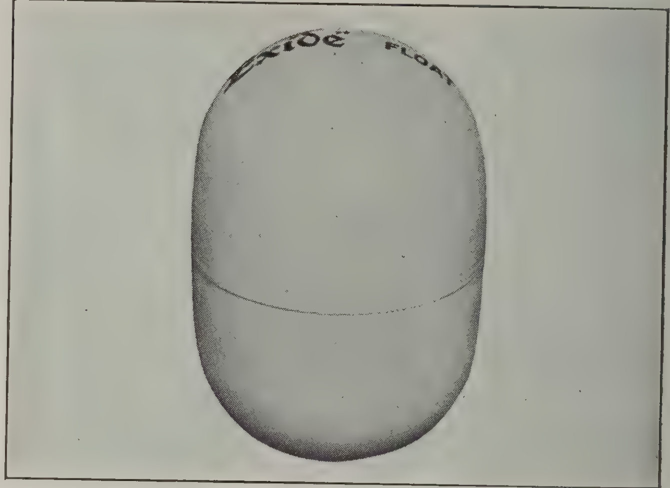
Fig. 4—Showing Master Controller With Cover Removed

This electrification will be watched with considerable interest for while this division extends over a fairly level country and no such tonnages are encountered as are handled in America, the fact that a complete steam division is to be electrified insures a direct comparison between the operation by steam and electricity and many interesting facts are expected to be obtained from this electrification.

A Float for Storage Batteries

A float for indicating the height of the electrolyte in car lighting storage batteries has been brought out by the Electric Storage Battery Company, Philadelphia, Pa. The device consists of a hollow, egg-shaped float made of celluloid, inside of which at one end is fixed a small lead weight. The float has a diameter of 1½ in. and is about two inches long.

When in use it is placed in the filler opening of the battery cell and floats on the surface of the electrolyte.



The Exide Float for Indicating the Height of Electrolyte in Storage Batteries

It is of course suitable only for batteries which have a filler opening more than 1½ in. in diameter and it is designed especially for use in E. S. B. batteries. It affords a great convenience, particularly when used in the rear cell in the battery compartment under the car. When the battery contains the proper amount of electrolyte, the float can be seen when the filler opening cap is removed. When the electrolyte is low, the float in the rear cell cannot be seen from the front of the battery box.

Lightning Arresters for 3,000-Volt D. C. Railroad Service

Electrolytic lightning arresters for use on 3,000-volt electric locomotives have been designed and built by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

The working parts of the arrester consist of 12 electrolytic cells with balancing resistors and an expulsion fuse. The fuse is mounted on the door of the case so that the opening of the door opens the arrester circuit. The fuse chamber is lined with asbestos lumber and is provided with a chute at the top which extends out of the operating chamber of the locomotive cab.

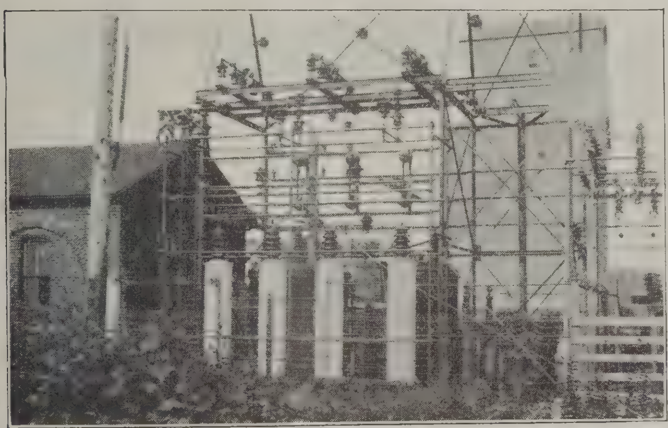
The electrolytic cells are held in place on a felt pad by a jar holder with two cells as a unit. Each unit is held in place by a stud projecting from the back of the case and the jars can be removed by unscrewing a wingnut from this stud and by removing the terminals on the resistor panel.

The cells are shunted by a resistor for the purpose of dividing the voltage drop equally among them. The resistors are mounted on a micarta panel that serves as the terminal board.

Repairing Lightning Arrester or Transformer Tanks in Service

It sometimes happens, due to expansion and contraction, that the seam of an electrolytic lightning arrester tank or transformer tank will develop a slow leak while the equipment is in service and it is more than likely that the equipment cannot be spared from service without a lot of inconvenience.

One day when I was new on the job, it was my second or third day, I was asked if I could fix a lightning arrester tank that had a slow leak. I wanted to make an impression so I said yes without consulting my better judgment, and having said yes, it was up to me. When I looked at the tank, which was cylindrical and about eight feet high, I saw that the side seam had opened and that the insulating oil was oozing through the seam and dripping off the bottom of the tank slowly.



The Stain on the Second Tank Was Caused by the Escaping Oil

I confess I wasn't at all sure the job could be done, but I had to make an effort and tried the only thing I could think of. I bought a little litharge and a few ounces of glycerine at a drug store. When these are mixed together they form a paste which slowly hardens becoming first a tough, spongy mass not unlike very soft lead in character after which it becomes very hard. It is not soluble in oil.

After making up a thick paste of the litharge and glycerine, I opened the charging switches, discharged the tanks and applied a thick coating of the paste to the outside of the tank over the seam. The paste stuck to the tank all right but it didn't stop the leak at all and I was about ready to believe the idea was a failure when I noticed that the oil which was continuing to leak out as before was coming through a number of pin holes in the mixture which by this time was nearly hard. I tapped one of the pin holes with the round end of my ball pien hammer and to my surprise and delight the hole was closed. By applying the same treatment to all of the little pin holes, the leak was stopped completely. After that I applied another coating of the paste as a factor of safety, applying a coat of paint to that later. The tank has now been in service for some time and it is still as tight as any of the other three in the same arrester.

Wireman, Hastings, Minn.

Sand

I observed a locomotive in the railroad yards one day,
It was waiting in the roundhouse where the locomotives stay;
It was panting for the journey, it was coaled and fully manned,
And it had a box the fireman was filling full of sand.

It appears that locomotives cannot get a grip
On their slender iron pavements, 'cause the wheels are apt to slip.
And when the reach the slippery spot, their tactics they command,
And to get a grip upon the rail they sprinkle it with sand.

If your track is steep and hilly, and you have a heavy grade,
And if those who've gone before you have the rails quite slippery made;
If you ever reach the summit of the upper tableland,
You'll find you'll have to do it with a liberal use of sand.

If you strike some frigid weather and discover to your cost
That you're liable to slip on a heavy coat of frost,
Then some prompt, decided action will be called into demand,
And you'll slide clear to the bottom if you haven't any sand.

You can go to any station that is on life's schedule seen,
If there's fire beneath the boiler of ambition's strong machine;

And you'll reach the place called Richtown at a rate of speed that's grand,
If for all the slippery places you've a good supply of sand.

THE QUESTION CORNER

Answers to September Questions

1. *I frequently want to know how much electrolyte there is in a car lighting battery which is in such a position that I can't see into the vent hole. With a bit of stick or a piece of broken separator, I can usually tell whether the electrolyte is covering the plates or not, but isn't there a better way of telling just how much there is? Is there any way of telling how much sediment there is in the bottom of a cell without taking the cell apart?*—P. T. B.

2. *When a motor is to be used to drive a machine tool, there is often a question as what kind of drive to use, belt or gear. Can you tell me something about the limitations of the two kinds of drive with reference to horsepower and motor speed?*—L. M. S.

1. We have brought out a device which assists materially in showing that car lighting cells have the proper amount of electrolyte. This is of particular advantage in the rear cells of two-compartment crates, where it is practically impossible, at present, to determine this without pulling out the batteries. This device shows immediately when a cell has been sufficiently flushed.

Referring to the second part of question 1 regarding sediment, we are glad to furnish sediment probes to any of the car lighting fraternity with our compliments. These probes consist of long, narrow, wooden strips, which can readily be slipped down into one of the grooves of the wood separator to the bottom of the cell. After being allowed to stand for a few moments it is then withdrawn, and the amount of discoloration shows clearly the amount of sediment. This does not require opening the cell in any way, and takes but a few moments time.

Manager, Railway Sales,
The Electric Storage Battery Company,

* * *

The device for showing the height of electrolyte developed by the electric storage battery is described in the New Devices Section of this issue. As it is designed for use with large filler openings, the following is suggested for use with batteries having filler openings less than 1½ in. in diameter.

Take a glass tube about seven inches long and one-quarter inch in diameter, wrap a little tape around one end of the tube, but not over the opening in the tube. The tape will prevent the slipping of the tube in one's fingers.

Place the other end of the tube in the vent hole in the lid, then place finger over the taped end of glass tube tightly and withdraw the tube from the cell. The electrolyte will remain in the tube until the finger is released showing the depth above elements.

2. Direct Current Motors-Belt Drive—The following limitations represent good practice in belting motors under normal conditions to relatively high speed drives:

Limit use of 1,800 or 1,700 r. p. m. motors to a maximum of 40 h.p.

Limit use of 1,500 r. p. m. motors to a maximum of 50 h.p.

Limit use of 1,200 or 1,150 r. p. m. motors to a maximum of 75 h.p.

Limit use of 900 or 850 r. p. m. motors to a maximum of 125 h.p.

The above limitations are based on the use of pulleys as standardized by The Electric Power Club. The limitations will be less than those given when motors are belted to slow speed drives, such as countershafts.

Gears—The following limitations represent good practice in gearing motors, based on the use of steel pinions:

Limit use of 1,800 or 1,700 r. p. m. motors to 5 h.p.
Limit use of 1,500 r. p. m. motors to 10 h.p.
Limit use of 1,200 or 1,150 r. p. m. motors to 25 h.p.
Limit use of 900 or 850 r. p. m. motors to 50 h.p.
Limit use of 750 or 720 r. p. m. motors to 75 h.p.

The use of outboard bearings should be specified for general purpose motors with geared drive in frame sizes 75 h.p. 850 to 900 r. p. m. and larger.

Polyphase Motors-Belt—The following limitations represent good practice in belting motors under normal conditions to relatively high speed drives:

Limit use of 1,800 or 1,700 r. p. m. motors to a maximum of 40 h.p.

Limit use of 1,500 or 1,440 r. p. m. motors to a maximum of 50 h.p.

Limit use of 1,200 or 1,150 r. p. m. motors to a maximum of 75 h.p.

Limit use of 900 or 850 r. p. m. motors to a maximum of 125 h.p.

The above limitations are based on the use of pulleys as standardized by The Electric Power Club. The limitations will be less than those given when motors are belted to slow speed drives, such as countershafts.

Gear—The following limitations represent good practice in gearing motors, based on the use of steel pinions:

Limit use of 1,800 or 1,700 r. p. m. motors to 5 h.p.
Limit use of 1,500 or 1,440 r. p. m. motors to 10 h.p.
Limit use of 1,200 or 1,150 r. p. m. motors to 25 h.p.
Limit use of 900 or 850 r. p. m. motors to 50 h.p.
Limit use of 750 or 720 r. p. m. motors to 75 h.p.

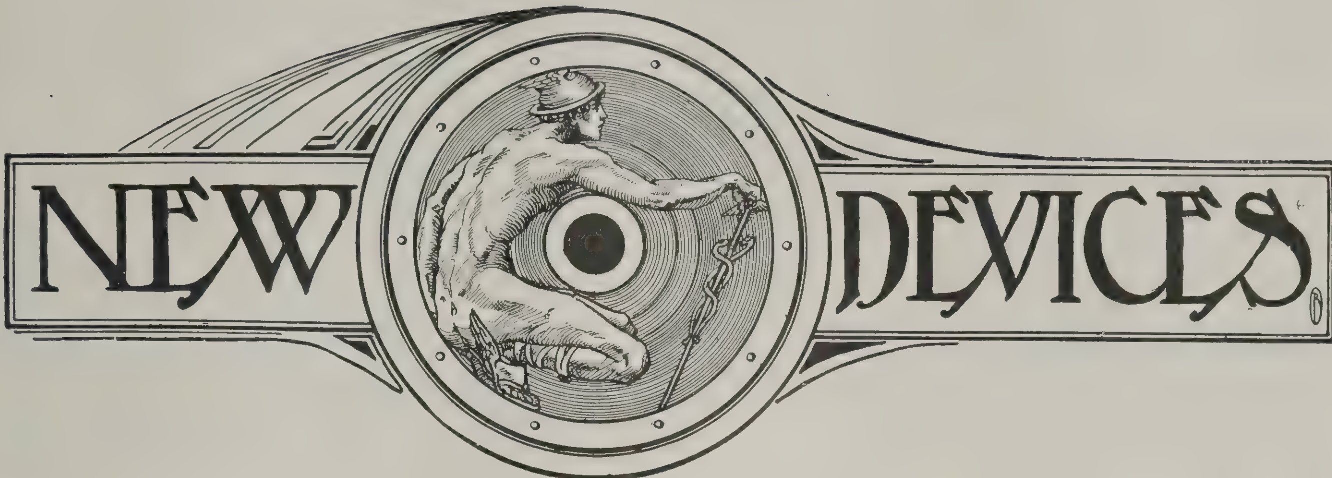
The use of outboard bearings should be specified for general purpose motors with geared drive in frame sizes 75 h.p. 850 to 900 r. p. m. and larger.

From the Hand Book of The Electric Power Club, March, 1922.

Questions for October

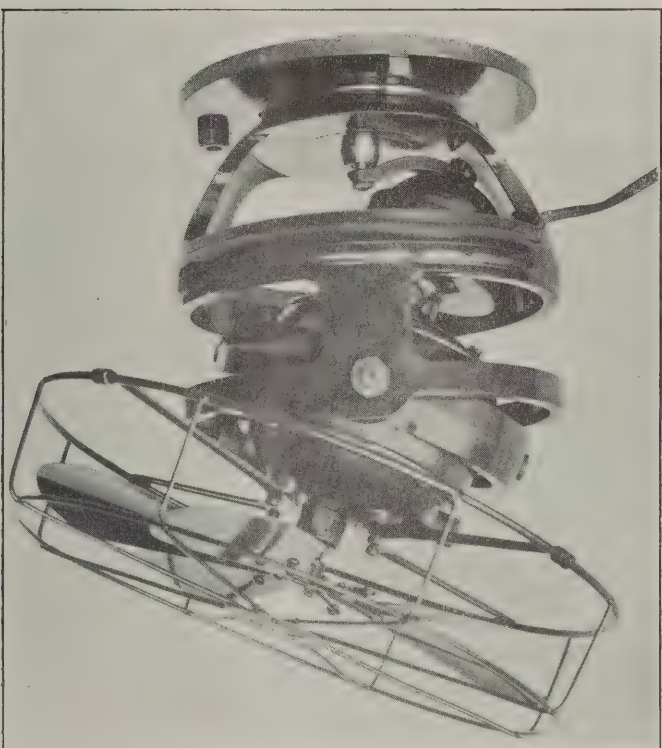
1. *If the current in a circuit in which the resistance is constant depends upon the pressure why is it that the current is the same in all parts of a series circuit when there is a voltage drop all along the line?*—R.A.

2. *If the voltage of a battery on open circuit is 2 volts and charging current is sent into it, would the potential rise at the battery terminals equal the drop due to internal resistance of the battery?*—A.O.



A Ceiling Fan for Cars

Aero-Cone has been suggested as a name for a new type of ceiling fan for dining cars and the compartments of Pullman cars. The fan, which has been designed and built by the Diehl Manufacturing Company, Elizabeth, N. J., will be distributed to the railroads by the Daniel Woodhead Company, Chicago, Ill. It consists of a series type motor driving a 12-in. or 16-in. 6-blade fan at a speed of about 1,700 r.p.m. The motor frame is mounted in a universal joint, surmounted on a ceiling base. The incoming circuits to the motor are brought in through and are insulated from the trunnion ball bearing of the universal joint. Flexible leads are eliminated and no part of the frame is live.

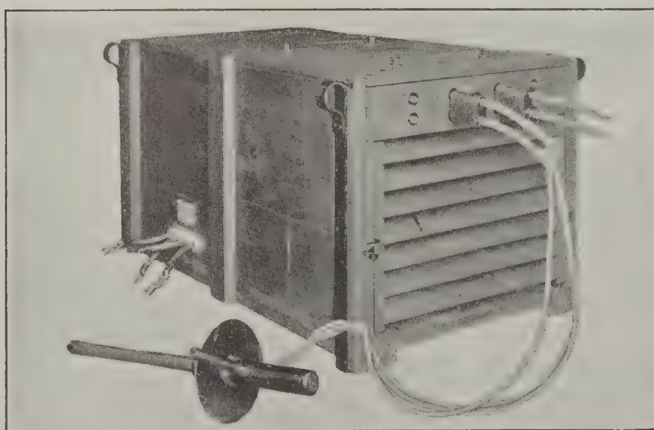


Aero-Cone Ceiling Fan for Diners and Pullman Cars

The upper extremity of the motor frame rotates on an arm about a pivot in the center of the ceiling plate. This arm is connected through a worm gear reduction to the armature shaft. The gear ratio is about 280 to 1. As the fan rotates about the pivot, the limits of the air set in motion are included in a cone which has its apex at the fan. By varying the length of the rotating arm, the base of the cone can be made wide or narrow as desired. The fan has a smooth rolling motion that is pleasant to watch. It will be supplied either for inset or surface mounting and in the latter case, will be equipped with an ornamental casing.

A Cutting and Welding Transformer

The latest development of the Electric Arc Cutting & Welding Company, Newark, N. J., is a 600-ampere machine designed especially for rivet cutting and carbon arc welding. It consists of a transformer of special design, the core of which is made of silicon steel. The primary is wound with double asbestos covered wire with micanite between layers and double micanite and ¼-in. asbestos spacers between the primary and secondary coils. The secondary is wound with stranded, bare, copper cable. There are large air ducts between the iron and the copper and between the copper layers and a special bucket type of ball bearing blower is used to drive air through the ducts. The blower motor is connected so that the blower is in operation at all times that the power is on.



A 600-Ampere Outfit for Rivet Cutting and Carbon Arc Welding

A magnetic switch in the primary keeps the primary circuit open at all times when the electrode is not in con-

tact with the work or when the arc is not drawn. This is accomplished by a small pilot transformer of 100 watts capacity, which is also used to operate the blower, the pilot transformer circuit being made by the electrode touching the work and the primary load being used to hold the magnetic switch in closed position. When the cutting current is broken at the arc, the magnetic switch automatically opens and cuts the machine, leads and also the magnetizing current off of the transformer. It is a combination safety device and power saver.

The characteristics of this machine are different from those required in machines for metallic electrode welding in that the voltage across the arc is higher and that the drooping characteristics so desirable in arc welding are changed so that the voltage drops off less rapidly as the current rises.

A Pipe Wrench for Difficult Corners

The Little Giant pipe wrench, embodying several interesting new features, has just been put on the market by the Greenfield Tap & Die Corporation, Greenfield, Mass. This wrench has the "end opening" feature which is familiar to users of machinists' wrenches. Its application to pipe turning can readily be seen by a glance at the illustration.

One important advantage of the Little Giant wrench

Little Giant Pipe Wrench Embodying New Principle of Design

is the ease with which it can handle pipes in corners, close to walls, and similar confined places. The person using it can set it straight on the pipe as he would a pair of pliers, instead of having to fit the jaws on from the side. There are only three parts: a handle and jaw in one piece, which is drop forged and heat treated; a movable jaw, likewise drop forged and heat treated; and a hardened steel nut. In spite of the absence of springs the wrench is said to take hold and release instantly at the option of the user.

The new wrench has been designed for maximum strength, the 14-in. size having successfully withstood stresses in excess of 4,700 in. lb. without slipping or bending. Yet owing to the elimination of extra parts the wrench is relatively light in weight.

Another feature is the double set of teeth on the main jaw. The movable jaw can be engaged at the option of the operator with either of these sets of teeth with consequently lengthened life. On the large sizes, 14-in. and greater, two additional sets of teeth are provided, making four in all, and the movable jaw can be reversed to engage these additional sets of teeth, which are below the adjusting nut. This is very useful in connection with certain classes of work, besides tending to quadruple the life of the tool.

The Little Giant wrench is being manufactured in 8-, 10-, 14-, 18- and 24-in. sizes, of which the three smaller sizes are already on the market.

Steel Car Lighting Fixtures

Several new steel lighting units for railway cars have been developed by the Safety Car Heating and Lighting Company, New Haven, Conn., which have practically all of the desirable features of cast iron and brass fixtures, with some additional advantages.

The ceiling fixture shown in Fig. 1 is fitted with an opal glass bowl and can be used with either 75- or 100-watt gas-filled lamps. Inside the fixture, fastened to the ceiling plate by machine screws, is a white enamel reflec-

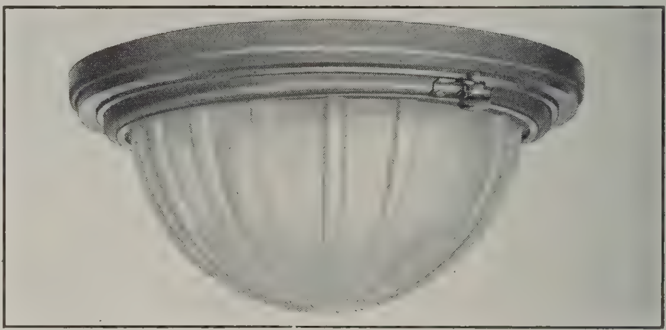


Fig. 1—Ceiling Fixture for Use With 75 or 100-Watt Gas-Filled Lamps

tor, which has a perforated rim to facilitate air circulation. The ceiling plate, in turn, is bolted to the car ceiling. An ornamental ceiling ring, which fits the ceiling plate, is furnished to suit any ceiling curvature. The bowl is secured in a steel bezel ring by spring clamps and is cushioned by a felt ring. The bezel is hinged to the ceiling ring and is closed with a screw locking catch. The fixture is supplied with either enamel or metallic finish.

The fixture shown in Fig. 2 is identical with that shown in Fig. 1, except that it is made with a square instead of a round base or ceiling ring.

The lighting unit shown in Fig. 3 supports a standard "safety" shade holder. Inside of the fixture there is a

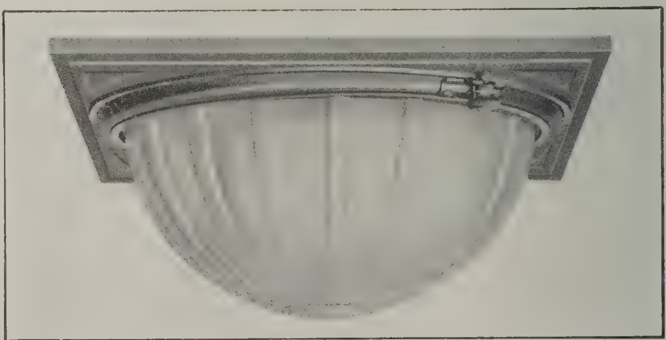


Fig. 2—Ceiling Fixture With Square Base or Ceiling Ring

steel socket support which is attached separately to the car ceiling; this feature permits removing the ornamental base, stem and shade holder without disturbing wiring connections. The position of the socket in this support is adjustable, permitting the use of any size of lamp or reflector desired. This fixture is also supplied with either enamel or metallic finish.

The baggage car fixture, shown in Fig. 4, has a 12-inch steel reflector finished white enamel inside and olive green enamel outside. It is designed for use with a 50-watt vacuum type or gas-filled lamp. The lamp is screwed

into a poreclain receptacle which permits wire connection without splicing. The receptacle is held by machine screws in the cast iron junction box and the reflector is

Fig. 3—The Adjustable Lamp Support in This Fixture is Attached Separately to the Car Ceiling

secured to the junction box by a plate which also acts as a cover for the box. The slotted hexagonal screws make possible the removal of the cover and reflector as a

Fig. 4—Baggage Car Fixture Designed to Allow a Maximum Amount of Head Room

unit. This unit provides the proper light distribution for baggage cars and maximum amount of head room under the fixture.

A New Grade of Brush

A new electro-graphitic brush known as "259" has been placed on the market by the National Carbon Co., Inc. Tests on a large variety of d. c. motors and generators, and on the d. c. side of rotary converters have demonstrated that it is adapted to a wide range of voltages, current densities and speeds on under-cut commutators.

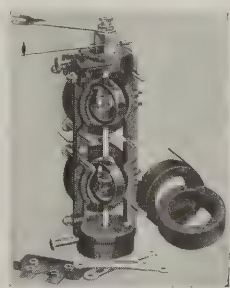
Graphic Meters for Either Alternating or Direct Current Service

Graphic voltmeters and graphic wattmeters for either alternating or direct current service are now being made by the Esterline-Angus Company, Indianapolis, Ind. The meters are known as the utility voltmeter and utility wattmeter.

The Utility Portable Recording Voltmeter

The voltmeter is shown in the accompanying illustration. It is made in the portable type, the case being of aluminum, finished in hand rubbed, baked enamel. The clock is an eight-day, marine type, enclosed in a separate metal case. Five chart speeds of ¾ in., 1½ in., 3 in., 6 in. and 12 in. per hour are obtainable. If desired, the clock can be fitted so as to give all of the foregoing hourly chart speeds and the same speeds in inches per minute as well. The charts are 6 in. wide and 90 ft. long. The weight of the meter is 20 lb.

The measuring element embodies several unique features. A moulded bakelite frame is used. The moulded bakelite is used because of its high insulating properties and because it facilitates accurate assembly. The moving system, instead of being mounted on a staff carried by pivots and jewels, is supported on a taut steel suspension wire. The use of the suspension wire eliminates friction and reduces the risk of damage by shock, jar and vibration, thus making the meter particularly suitable for portable service.



The Measuring Element of the Voltmeter Showing Bakelite Frame and Steel Wire Suspension.

The ink well and damper are both moulded integrally with the frame, and are so constructed that the ink will not spill with ordinary handling. Utility voltmeters are furnished in the following ranges: 0-150; 0-300; 0-600; 0-750. They are also furnished with combinations of two, three or all four of the above ranges.

The utility wattmeter in external appearance is practically identical with the voltmeter and it is similar in construction. Like the voltmeter, it can be used on all commercial frequencies of alternating current, and on direct current circuits. It is so wired that it can be used as a single, two phase or three phase meter on alternating current and as a two-wire or three-wire wattmeter on direct current circuits. The wattmeter is made for the same voltage ranges as the voltmeter and current transformers and shunts may be had so that the meter can be used on circuits carrying from 5 to 800 amperes.

General News Section

The Monitor Controller Company, manufacturers of the "Just Press a Button" system of automatic control for motors, have recently established a branch office at Birmingham, Ala.

One of the reasons why copper shipments abroad have shown a substantial decrease within recent weeks is the fact that Japan has placed a practically prohibitive tariff on the metal. The continued decline in the value of the mark has caused a reduction in the volume of German buying. Both Germany and Japan have been the two countries that have been taking most of America's copper, outside of domestic consumption.

The Gibb Instrument Co., of Detroit, manufacturers of electric welding equipment, announces the removal of plant and offices to Bay City, Mich., effective December 1. The purpose of this move is to provide greatly increased manufacturing facilities to take care of a rapidly increasing business. For the past two years this company has concentrated on the development of automatic and semi-automatic arc, spot and seam welders.

There is now in service on the Canadian National a self-propelled passenger car which derives its power from steam rather than from gasoline. In appearance the car resembles the usual steam railroad passenger or interurban electric car. The body is of steel construction and the car is equipped with standard couplings. The power plant in the car embodies the principles used in the Stanley steam automobile.

An investigation made in St. Louis over a 48-hour period to determine the degree of precaution taken by pedestrians and vehicle drivers at railway crossings showed that of 1,216 pedestrians, only one stopped and looked in both directions before proceeding over the crossing, that two persons looked in both directions but did not stop, that nine per cent looked in one direction only, and that 88 per cent did not stop or look to right or left. The investigation also showed that 91 per cent of the drivers of 2,931 automobiles failed to stop or look in either direction.

The Regan Safety Devices Company, New York City, announces that the installation of the Regan intermittent contact automatic train control apparatus on the Chicago, Rock Island & Pacific, throughout its Illinois division, 164 miles, double track, is to be begun immediately, with the expectation of completing the work in 100 working days. The directors of the railroad company on Tuesday, November 14, confirmed the decision, announced some time ago, to equip this portion of the Rock Island System in compliance with the order of the Interstate Commerce Commission. The apparatus is now being made at the Regan Company's factory at Niagara Falls, N. Y. That part of this train control system which is already installed, Blue Island, Ill., to Joliet, 25 miles, has been in service three years.

Illinois Central Roundhouse at Council Bluffs Partially Destroyed by Fire

Fire broke out in the roundhouse of the Illinois Central at Council Bluffs, Ia., recently, presumably due to defective electric light wiring which ignited the roof of the building and destroyed all of the wooden parts of the structure. Eight engines were in the building at the time of the fire. The total damage to the engines and the roundhouse is estimated at $21,000.

Electrification of Argentine Transandine Railway

An increase amounting to 1,500,000 gold pesos over the sum already allotted is provided by a proposed law recently submitted to the Argentine congress, to be used for the electrification of the Argentine Transandine Railway between Zanjon and the Chilean frontier, according to Commerce Reports. A contract between the government and the Argentine Transandine Railway has already been approved under the provisions of the law of October 13, 1921. This agreement provides for joint administration of the Chilean and Argentine Transandine roads, connecting Mendoza and Los Andes. It stipulates that the government shall place at the disposition of the railway company bonds of the Argentine external loan, not to exceed 2,500,000 gold pesos, bearing interest at the rate of 5 per cent per annum, with 1 per cent amortization.

The new line, for which the additional 1,500,000 pesos has been requested, is approximately 45 kilometers in length and connects with the section of the Chilean line, which is also to be electrified.

Train Control Modifications and Changes

The Interstate Commerce Commission has modified its automatic train control order to provide that the Northern Pacific may install automatic train stop or train control devices on one full passenger locomotive division between Mandan and Dickinson, N. D., in lieu of the installation required on the portion of its line designated in the original order, but the Northern Pacific's petition, in so far as it requests a modification of the order so as to permit of the use of an automatic train stop under the control of the engineman, who may, if alert, forestall automatic brake application and proceed, is denied. The commission has also denied a petition of the Chicago, Burlington & Quincy for a modification with respect to the extent of the installation required on its road, and also the joint petition of the New York Central, Boston & Albany, Cleveland, Cincinnati, Chicago & St. Louis, Michigan Central and the Pittsburg & Lake Erie, asking a postponement of the date.

By an order issued on October 14 the Interstate Commerce Commission, in lieu of the requirement in its previous order, has authorized the Southern Pacific to

install automatic train control between Oakland, Cal., and Tracy; has authorized the Philadelphia & Reading to install between Camden, N. J., and Atlantic City; and the St. Louis-San Francisco to install between Springfield, Mo., and Sapulpa, Okla. In all other respects, the order of June 13 is to remain in full force and effect.

New Haven Orders Seven More Electric Locomotives

The contract for five electric locomotives recently placed by the New York, New Haven & Hartford with the Westinghouse Electric Manufacturing Company, as noted in the October issue of the *Railway Electrical Engineer*, has since been increased intermittently until a total of twelve locomotives are new covered by the contract. The entire number will be practically a duplication of those now in operation in high speed passenger and freight service into the Grand Central Terminal, New York City.

Each locomotive will weigh approximately 181 tons and will be of the 2-6-2-2-6-2 type. The equipment will be such that the locomotives can haul a 900-ton train in express passenger service on either 11,000 volts alternating current or 600 volts direct current. The locomotives will be driven through gears and quills by six twin motors. When the twelve new locomotives are put into service there will be a total of 117 electric freight, passenger and switcher type locomotives in operation on the New Haven.

Legal Penalties Will Not be Included in Approved National Safety Codes

Clauses relating to legal penalties or to methods of enforcement will not be included in the safety codes approved by the American Engineering Standards Committee. This policy was established at a meeting of the A. E. S. C. in New York on October 20.

This action was taken on the suggestion of the Safety Code Correlating Committee, which acts in an advisory capacity to the American Engineering Standards Committee in matters concerning safety codes.

It is the feeling both of the men engaged in the furtherance of standardization in industry and of practically all state officials, that legal penalties for failure to conform with established state safety codes and methods of enforcement can best be decided by each state for itself.

A. E. S. C. Appoints Special Committee on Wood and Tubular Poles

The American Engineering Standards Committee announces the appointment of a special committee to consider and make recommendations to the A. E. S. C. concerning the application of the American Electric Railway Association for approval as American Standards of its specifications for wood poles and tubular poles.

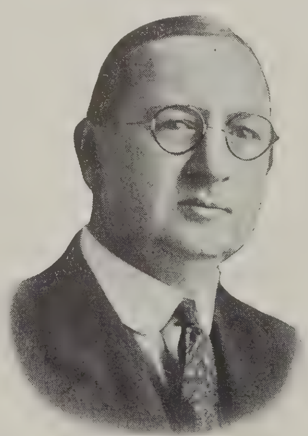
Twenty-one men, representing producers and consumers of both types of poles, as well as the public, are on this committee. The importance of this subject to the lumber and iron industries, steam and electric railways, and other users of wood and tubular poles becomes apparent when it is known that several millions of poles are purchased each year.

Personals

Edward S. M. Macnab, car lighting engineer of the Canadian Pacific, was elected president of the Association of Railway Electrical Engineers at the thirteenth annual convention of the association which was held in the La Salle Hotel, Chicago, on October 31, to November 3, inclusive. Mr. Macnab was born in Dublin, Ireland. He was educated in the Mountjoy school in Dublin and in the City of Dublin Technical schools. He completed his education at the Royal College of Science in Dublin. Beginning in 1900, he served a five-year apprenticeship with the Midland Great Western railway, a road which has suffered much during the recent troubles in Ireland. After completing his apprenticeship he was made general foreman of passenger car shops, a position which he held for three years. During 1908 he was associated with electrical contracting firms in England. In 1909, Mr. Macnab came to Canada with the Canadian Pacific. He was made electrical foreman of the Angus shops in Montreal in 1910 and in 1911 was appointed car lighting inspector, which position he held until 1914. In 1914 he was appointed car lighting engineer, the position he now holds. Mr. Macnab is a member of the Institution of Civil Engineers in Ireland and has been a member of the Association of Railway Electrical Engineers since 1909.

E. S. M. Macnab

F. F. Rohrer, assistant to manager of both the power and railway departments of the Westinghouse Electric & Manufacturing Company, has been appointed general contract manager of that company. In his new appointment, which is effective immediately, Mr. Rohrer will be a member of the staff of W. S. Rugg, general sales manager. Mr. Rohrer assumes responsibility for service to customers under contracts and will have general supervision of all contract and order work of the company. In addition to this general work, he will continue to have direct charge of the contract work of the power and railway departments which duties he performed in his previous position. Mr. Rohrer was born in Harrisburg, Pa., April 22, 1876, and attended school there until 1895. He



F. F. Rohrer

entered the employ of the Westinghouse Company as a student in 1896. After serving in the shops for four years, during which time he obtained extensive training in the manufacturing and testing departments he was transferred to the sales department. His services in the latter department have included a number of positions of responsibility. During the war, Mr. Rohrer was a member of the Committee of the War Industries Board appointed to conserve the production of turbine-generating equipment for government needs. After the armistice was signed he became the representative of the Westinghouse Company in the settlement of contracts which were terminated as a result of the ending of the war. When this work was completed he served in the capacity of assistant to the managers of both the power and railway departments, which position he held until his present appointment.

Daniel Woodhead, president of the Daniel Woodhead Company, Chicago, Ill., was elected president of the Railway Electrical Supply Manufacturers' Association at the annual meeting of that association held at the La Salle Hotel in Chicago on November 2. Mr. Woodhead was born in Manchester, England, on December 4, 1883, and came to the United States in 1889. He graduated from Wesleyan University, Middletown, Conn., in 1907. He taught in St. Mark's school in Boston, Mass., for three years, and on January 1, 1910 joined the staff of the Central Electric Company as sales engineer. The Daniel Woodhead Company was incorporated on March 1, 1921, and he has been president of the company since its formation. He has been a member of the Association of Railway Electrical Engineers since it was organized in 1908 and he served on the executive committee for three years.

Obituary

Edwin Hurlbut, formerly railway representative of the Crouse-Hinds Company, with headquarters in Chicago, died at his home in Evanston, Ill., on October 7. Mr. Hurlbut was born in Elk Rapids, Mich., September 7, 1882, and attended the Lake View high school and Northwestern university in Evanston. On leaving school he entered the service of the Johns-Manville, Inc., as sales representative and later served in the same capacity with the Porter & Berg Company (now the Electric Service Supplies Co.). Soon after entering the sales organization of the Crouse-Hinds Company he entered military service in January, 1918. As a second lieutenant he served in France as engineer in charge of a flying squadron at Issondun. On his return he accepted a position as railroad sales representative of the Crouse-Hinds Company, covering the west and northwestern states with headquarters in Chicago. In July, 1921, he resigned his position to enter business for himself in the battery supply trade in Evanston, Ill.

Edwin Hurlbut

Trade Publications

Safety Car Equipment.—Bulletin No. 44015 describes the safety car equipment manufactured by the General Electric Company, Schenectady, N. Y. The bulletin contains 20 pages and illustrates and describes the details of apparatus used on safety cars made by that company.

Electric Hoists.—Sprague electric type WX worm drive hoists are described in a two-page folder issued by the Sprague Electric Works of the General Electric Company, New York, N. Y.. The folder includes a drawing and a brief description of each part.

Electric Furnaces.—Baily electric furnaces for melting non-ferrous metals are described in a six-page folder issued by the Electric Furnace Company, Salem, Ohio. The folder also lists and illustrates a large number of products for the manufacture of which the electric furnace is most suitable.

Multi-Speed Motors.—Applications of Watson multi-speed motors for adjustable speed control on alternating current polyphase circuits are described in a two-color, illustrated, 12-page bulletin issued by The Mechanical Appliance Company, Milwaukee, Wis. These motors are designed to run at any one of four different speeds, namely, 600, 720, 900 or 1,200 r. p. m.

The Weston Electrical Instrument Co., of Newark, N. J., announces a new and unique line of small portable instruments for use on alternating current circuits, known as the "Weston, Jr." The group, described in Bulletin 2006, comprises wattmeter, voltmeter, ammeters and milliammeters which will undoubtedly fill a real need in many fields where small instruments can be used.

Bearing Metals.—The A. W. Cadman Manufacturing Company, Pittsburgh, Pa., has recently issued engineering bulletins M-1 and M-2. The first bulletin deals with the properties of bearing metals, especially those alloys known as Cadman metals. The second contains miscellaneous technical information pertaining to bearings and bearing metals, discussing such questions as the theory of bearing metals, friction in bearings and permissible bearing pressures.

Train Lighting Equipment.—The Safety Car Heating & Lighting Co. has recently issued two new catalogues and an elaborate folder which will be of interest to anyone connected with train lighting work and of especial interest to the users of safety equipment. One of the catalogues bears the title, "Operation of Under-Frame Car Lighting Equipment" and the other, "Pintsch Gas Car Lighting Fixtures." Both catalogues are profusely illustrated and contain 60 and 52 pages respectively. A novel and useful feature has been introduced in the Under-Frame catalogue, which consists of cross indexed tables which show at a glance which of the various generator parts can be used interchangeably on two or more of the ten types of generators manufactured by the Safety Company. The folder describes and illustrates the new "Putnam" lead storage battery for train lighting which is being introduced. Three small envelopes or pockets are attached to the folder, which contain small lead samples showing the construction of the battery plates.

Railway Electrical Engineer

Volume 13 DECEMBER, 1922 No. 12

The series of articles which ran through the year of 1921 and into February of 1922 under the general heading "Principles of Car Lighting By Electricity" was not really completed with the installment which appeared in the February issue. It had always been the object of the author, Charles W. T. Stuart of the Pennsylvania railroad, to write a final chapter, touching upon the subject of trouble shooting as well as describing some of the tools which, during his years of experience, he has found most useful. For one reason or another, Mr. Stuart has been unable to prepare this article as soon as he had hoped with the result that a number of months has elapsed since the last article of the series was published. On page 411 of this issue will be found the closing chapter of the Principles of Car Lighting by Electricity. The information contained in this article is certain to be of value to car lighting men everywhere and will be especially useful to new men engaged in the work.

Car Lighting Series Closes

Although the present article closes one series dealing with the various phases of car illumination, we want our readers to know that this does not close the general subject of car lighting by any means. While it is true that car lighting problems are of a very different nature from what they once were, it is also true that so long as cars are lighted by electricity, there will be problems to be met and it is our earnest desire and purpose to present to our readers each new feature and development in this work as it comes along. Pursuant with this thought it must be borne in mind that many original stunts in this line of endeavor come from the field. There is scarcely a car lighting man anywhere who does not put in to daily use some particular practice that he has found to be of value. In some instances these practical stunts or methods are more or less in general use, but often their usefulness is not generally known and the only benefits derived are those secured by the originator. How much better it would be for the car lighting fraternity if every time or labor-saving kink discovered by one member could be used by all. The *Railway Electrical Engineer* stands ready to shed the light of publicity on any method or device that has proved its worth, and urges the men engaged in car lighting work to send in descriptions of ways and means which they have found effective in the pursuit of their duties. By the publication of best methods and practices all may benefit and there is always a personal benefit derived by the writer of such articles, for articles of merit are certain to give their authors high standing in their professions.

Locomotive Headlight Wiring

Conduit systems used for locomotive wiring may be good or they may be bad, depending very largely upon the amount of inconvenience they cause when trouble develops in the circuits or when extensive repairs must be made on the locomotive. A conduit system which is poorly arranged is not only a source of annoyance by being inconvenient for testing, but it may easily prove to be a very real source of expense on account of the time lost in hunting trouble or in removing the conduit from the locomotive whenever necessary. There is perhaps no one thing that facilitates the location of shorts, grounds or crosses in any system of wiring quicker than sectionalizing the system. If means have been provided in the design for easily and quickly separating the system into a number of parts, it is obvious that in the great majority of instances wiring trouble can be quickly located in one part. The time saved in narrowing down the location of failure to a relatively small section of the entire system is a very important item, particularly where the number of locomotives is large or the corps of electricians relatively small. Careful design and installation of headlight wiring is a paying investment, although there are still some roads that have given the matter just enough attention to make their equipments a source of expense rather than a source of satisfaction. In contrast with this latter type of installation the system of headlight wiring used on the Michigan Central Railroad stands out as an excellent example of good practice and the article on page 405 of this issue describing the standard locomotive wiring of this road will be of interest to those who are closely associated with this work.

Train Control and Signals

It has been stated by signal men that automatic train control is fundamentally a signaling problem and should be engineered by the signal officers. That is true in part only. At the present time, under the existing state of development, it is probably more a matter for the signal man than it is for the mechanical or the electrical. For example, in developing a train control system, the matter of expediting the movement of traffic should be secondary only to that of safety. That is a matter to be worked out by the operators and the signal men. Furthermore, it is highly probable that signals will be used in conjunction with train control. That brings in questions like the following, based on a view expressed at a

recent train control meeting of the Society of Engineers, Chicago: "One of the prime requisites of a train control system that would remove a source of much contention Muldraughs Hill, 300 feet below the surface, it was still proceed' signal. This idea can be developed by using a signal system involving four distinct indications, i. e.: Clear, proceed at full speed; caution, proceed prepared to find next signal at stop; a new indication, similar to the tonnage signal now used in certain locations, that for the present may be called Alert, meaning that the immediate block is occupied but that the train may proceed at not more than a prescribed speed, prepared to stop short of any obstruction, and last, the absolute Stop at crossings, junctions or drawbridges. It is probable that train control may introduce the changes in signal indicators necessary to expedite the traffic sufficiently to overcome the delays caused by the limited speeds required by the speed control."

All such discussions are of primary importance, but those who settle them must not overlook the fact that the mechanical men will insist that such equipment as is installed on the locomotive will not only be dependable, but will control the locomotive in accordance with what is best practice in the control of freight and passenger trains. Insofar as the apparatus on the locomotive is concerned, it will be essential to a happy railroad family to consult the mechanical man about the equipment that is to be applied to the locomotive.

After the apparatus is installed, the electrical and air-brake men in the shops will probably be the most concerned as in most cases it consists of electro-mechanical devices for controlling the air brake system. The signal men will of course look after the equipment on the track, but this in most cases is relatively simple, particularly so in the case of the Clifford Control recently tried out on the Erie and described briefly in this issue. It is known as the "conductive" system and employs no roadside apparatus. An additional signal line wire is required but no roadside apparatus is employed. The future status of train control has not yet been determined, but it has progressed far enough to make it evident to the electrical maintainer that he should follow the course of its progress and get acquainted with the apparatus.

Radio for Railroads

A number of recent experiments with radio communication indicate that new uses for it will be found, some of which may easily have a railroad application. The principal uses to which it is put at the present time are, overland or transoceanic communication and radio broadcasting. Communication between one ship and another at sea, or between a ship and land, made possible by radio, is invaluable. Radio broadcasting as a source of entertainment and education needs no sponsor.

On trains the broadcasting has been applied as an entertainment feature and experiments have been and are being made to determine the practicability of communicating between stations and moving trains. When sleet storms have destroyed all communication by wire, radio has been pressed into service to reestablish this communication and keep trains moving until the wires could be replaced.

A test made recently on the Louisville & Nashville revealed some interesting facts. A broadcasting station program was being received on a train running out of Louisville, and while the train was in the tunnel beneath Muldraughs Hill, 300 feet below the surface, it was still possible to keep in touch with the station. The hill through which this tunnel extends is supposed to contain a considerable amount of iron. The fact that radio messages can be received under such circumstances has led the Bureau of Mines to make preliminary experiments with radio for underground communication. The Bureau hopes that radio may be used in the future as a means of effective communication between rescuers on the surface and miners entombed in mines following fires and explosions. Up to the present time no practical method of using radio for underground communication has been developed, but the experiments show that the electro-magnetic waves can be made to travel through solid strata.

If simple and effective apparatus can be designed whereby communication can be maintained between the head and rear ends of a train, the device would probably be used extensively. Such a device would be particularly suitable where pusher service is in use. It would minimize damage to equipment and would facilitate train handling generally.

There are many of the electrical men on the railroads who are radio enthusiasts. In fact, when a user of rubber jars was asked recently how he disposed of the scrap rubber from broken jars, he replied that what little scrap there was, was promptly made into panels for receiving sets. The *Railway Electrical Engineer* does not want to encourage the use of company material by employees for their own use, but believes that the radio enthusiasts should be encouraged. Within reason, the enthusiast will benefit both himself and his company. The earnest effort which he must make to familiarize himself with the principles of radio communication will necessarily improve his knowledge of all things electrical and his efficiency accordingly, and if radio finds a place in railroad operation, he will be ready to install and maintain the apparatus.

Indexes for 1922

Experience has taught us that all of our readers do not bind their copies of the *Railway Electrical Engineer* and for this reason it has become our practice to print only a limited number of yearly indexes. To all who desire such indexes for the year of 1922, we shall be glad to furnish copies. Requests should be addressed to the circulation department and should be received not later than January 1, 1923.

New Books

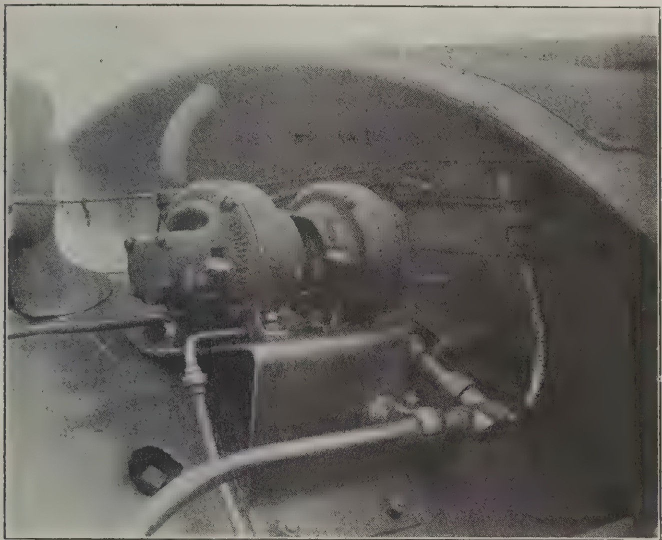
Patent Essentials—*By John F. Robb, 436 pages, plates, charts, 6 in. by 9 in., bound in cloth, $5.00. Published by Funk & Wagnalls Co., New York and London.*

The book treats of the nature of patents, the mechanism of their procurement, claim drafting, conduct of patent cases and special proceedings, including forms. It is the work of an experienced patent attorney, but is intended for laymen who wish to understand the essentials of law and practise before the Patent Office rather than for experts.

Standard Headlight Wiring on the Michigan Central

Entire Conduit and Wiring Systems May Be Easily Removed without Injury to Any of the Conductors

THE problems involved in the application of electrical energy to locomotive headlights and cab lights have been very important issues during the past few years. Since the electric headlight has become a part of almost every locomotive, many different wiring schemes have been tried on various roads with varying degrees of success. Some roads have been indifferent and given the subject but scant consideration, and they are certain to pay for their indifference in heavy maintenance costs sooner or later. On the other hand, there are roads where the importance of a good installation has been recognized and much careful thought has been devoted to the development of wiring methods and devices so that not only is the equipment more reliable in service, but the maintenance expense is relatively small. Of those roads which early appreciated the advantages of good headlight installation, there is perhaps none that has developed a more flexible conduit and wiring system than has the Michigan Central railroad.



Method of Mounting Turbo-Generator Set. Note Flexible Conduit and Detachable Connector on the Front of the Cab

This road has given the subject of locomotive lighting the kind of study that it deserves and, as a result, has developed standards which have proved to be very satisfactory.

Turbo-Generator

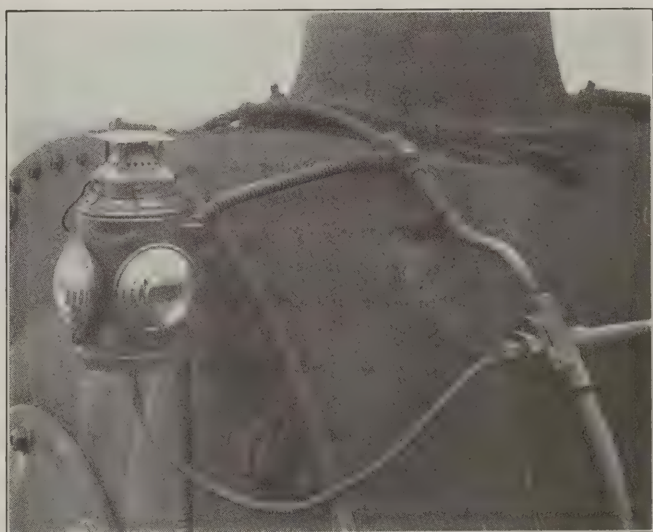
The turbo-generator which the Michigan Central has adopted extensively is the Pyle-National, type K-2, which is a 33-volt, 500-watt machine. The location of this unit is just ahead of the cab on the fireman's side. It is well up on the side of the boiler, in fact, the feet of the machine are only a few inches below the top of the boiler. A special base plate is bolted to the boiler shell and upon the horizontal portion of this plate, the turbo-generator is mounted. From the turbine end, which is forward, a half inch extra heavy drain pipe is led down the side of the boiler to a point just below the running board. A 1½-in. exhaust pipe extends upward and backward from the turbine making an angle of approximately 30 deg. with the vertical, the end of the pipe being approximately on line with the roof of the cab.

The steam supply to the turbine is controlled from the fireman's side of the cab. There are two valves in the supply pipe—one within the cab and another close to the turbine.

Arrangement of Exterior Conduit on the Locomotive

One of the unique features of the conduit arrangement on the locomotive is that the different portions of the conduit may be readily taken apart when the locomotive is sent to the backshop for repairs. It is not only possible to remove the conduit system from the locomotive, but this work is accomplished without cutting any of the wires. In the course of regular procedure whenever Michigan Central locomotives go through the backshop, the different sections or runs of conduit are removed, tested for grounds and shorts, tagged with the engine number and hung up in racks to be applied after other work has been done.

Since the system of wiring is unusual in a number of respects, it was necessary to develop many special conduit fittings at the time the layout was first planned. It is interesting to note that there have been very few changes since the original installation was made.

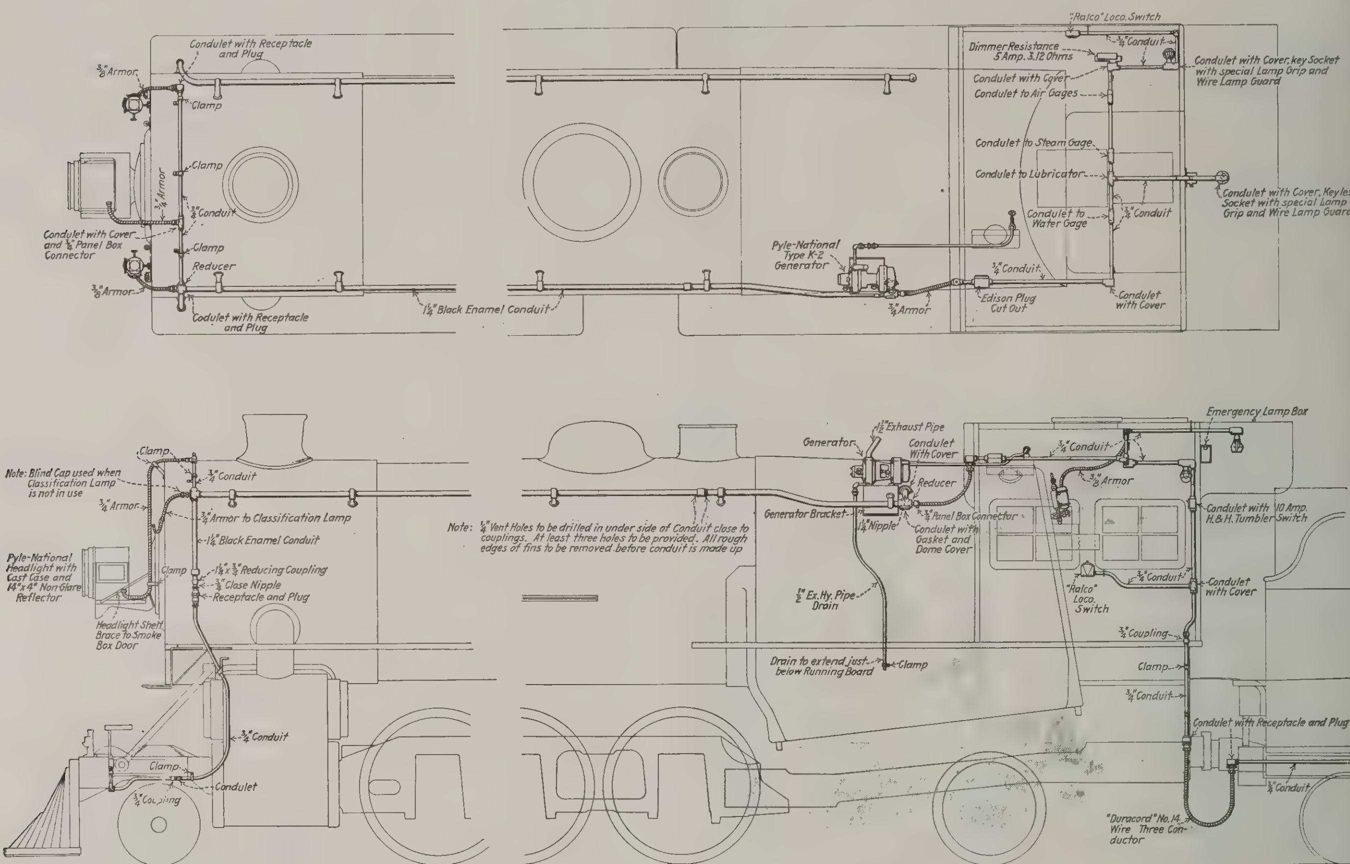


Arrangement of Conduit and Fittings on the Left Side of Smoke Box

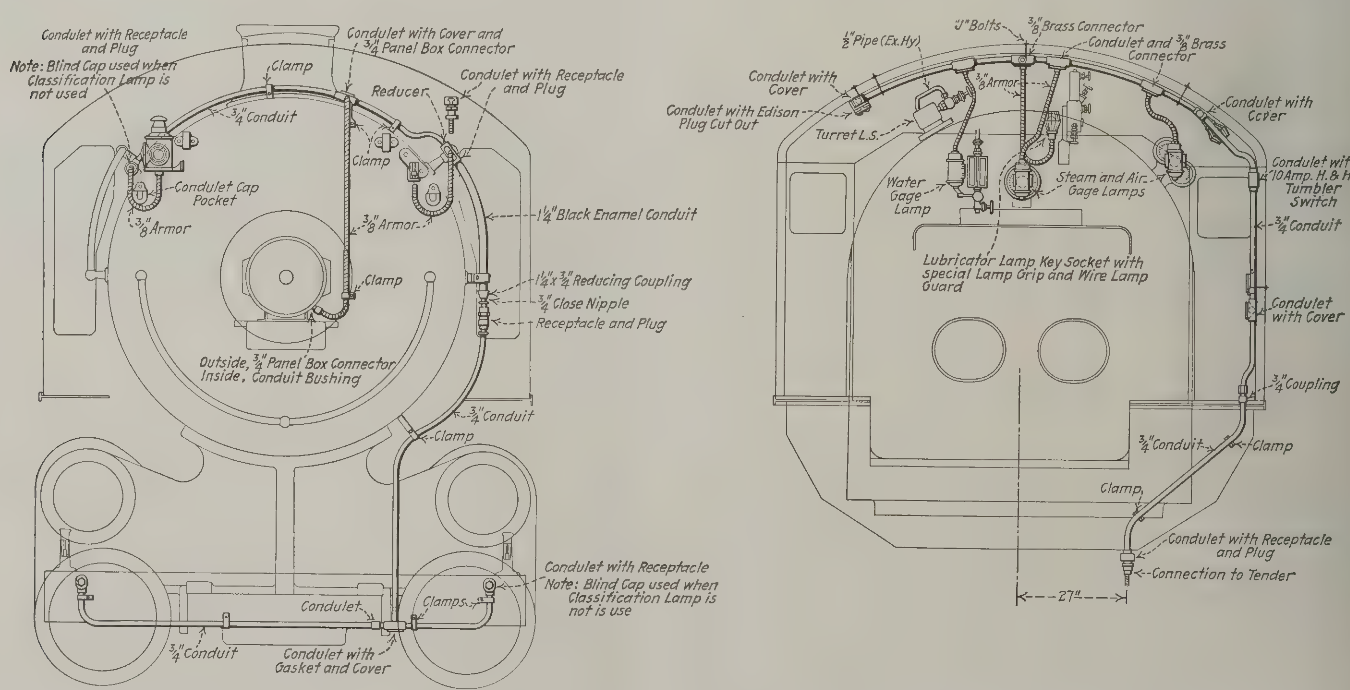
From the generator the wiring is carried forward in a 1¼-in. black enamel conduit which also serves the purpose of a handrail. At a point just back from the front end of the smokebox this conduit terminates in a condulet fitting from which another length of 1¼-in. conduit extends downward nearly to the running board, where a reducing coupling is used. From this point a ¾-in. conduit continues downward to the engine pilot, where it again branches to the right and left to the marker lamps.

The ends of these extensions are equipped with fittings carrying receptacles which may be closed with a blind cap when the marker lamps are not used.

From the condulet at the end of the horizontal portion of the handrail, ¾-in. conduit arches over the smokebox and terminates in another fitting from which ⅜-in. flexible armored conduit extends to the classification lamp on the right side of the locomotive. The ¾-in. conduit which arches over the smokebox also contains a T-fitting from which ¾-in. flexible conduit extends downward to the headlight located in front of the smokebox door. The classification lamp on the left-hand side of the locomotive is reached by a short length of ⅜-in. flexible armored conduit which extends from the fitting on the end of the horizontal portion of the handrail. In the event that the classification lamps, or the marker lamps,



Plan and Elevation of Conduit System on the Locomotive



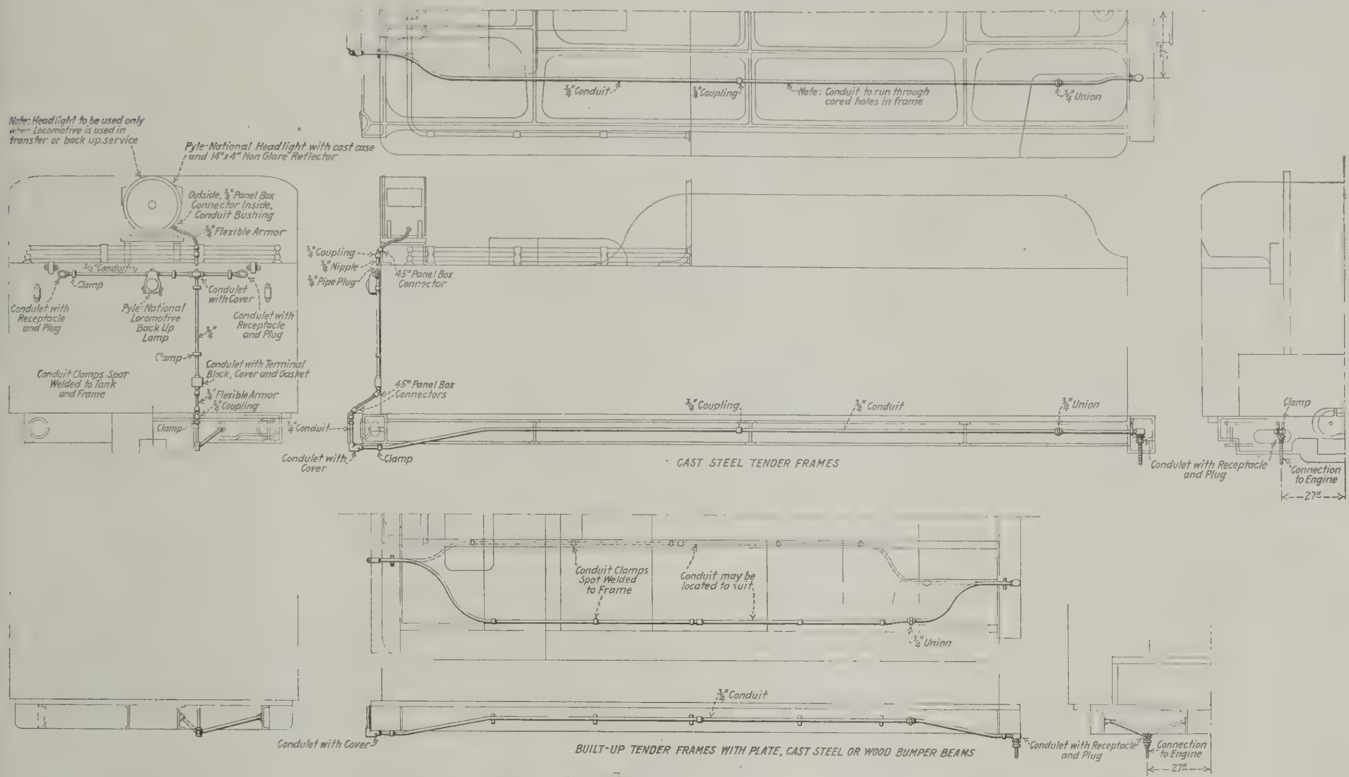
Left—Drawing Showing Arrangement of Conduit System on the Front End of Locomotive. Right—Conduit Arrangement Within the Cab

are not used, the conduit fitting from which the flexible conduit leads may be blanked with the proper blind cap.

Conduit Arrangement in the Cab

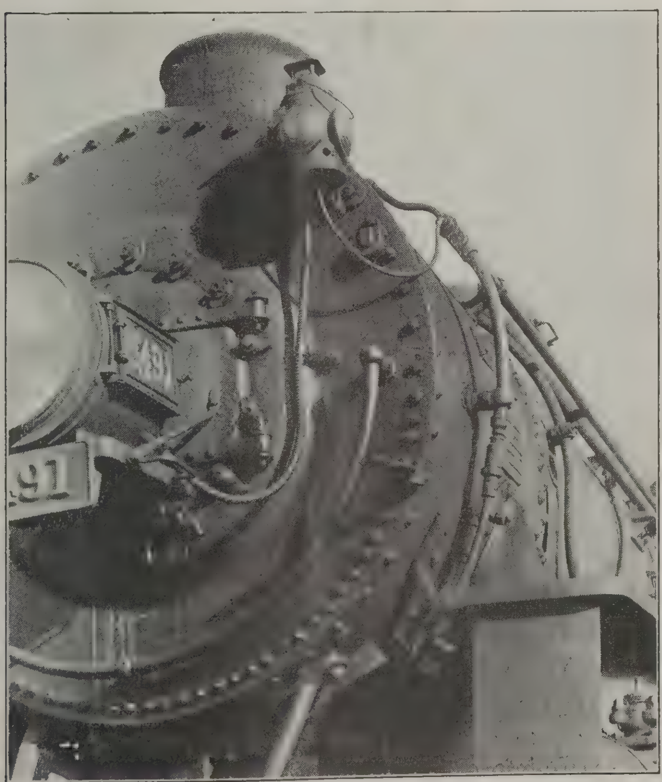
Extending toward the cab from the handrail conduit outside the cab. This fitting is equipped with a receptacle and plug so that both conduit systems and circuits on the outside of the locomotive may be readily separated from the cab conduit and wiring whenever it is desired.

From this junction point a short piece of conduit ex-

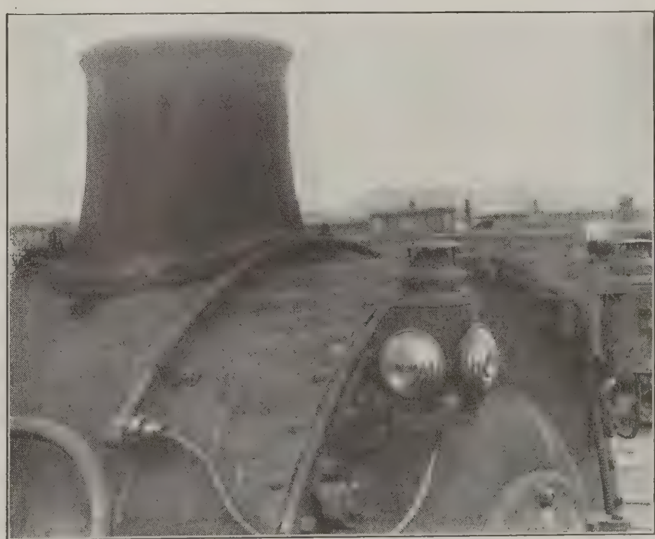


Drawing Showing Arrangement of Conduit System on Tender

fitting at the generator, ¾-in. flexible armored conduit brings the wiring to another special fitting located just tends through the front of the cab to another fitting which contains an Edison plug cutout. Three-quarter-inch conduit extends backward from this cutout about half the length of the cab roof where it makes a right-angle turn and arches over to the engineman's side. This arched



Front End View of Locomotive Showing the Various Runs of Conduit

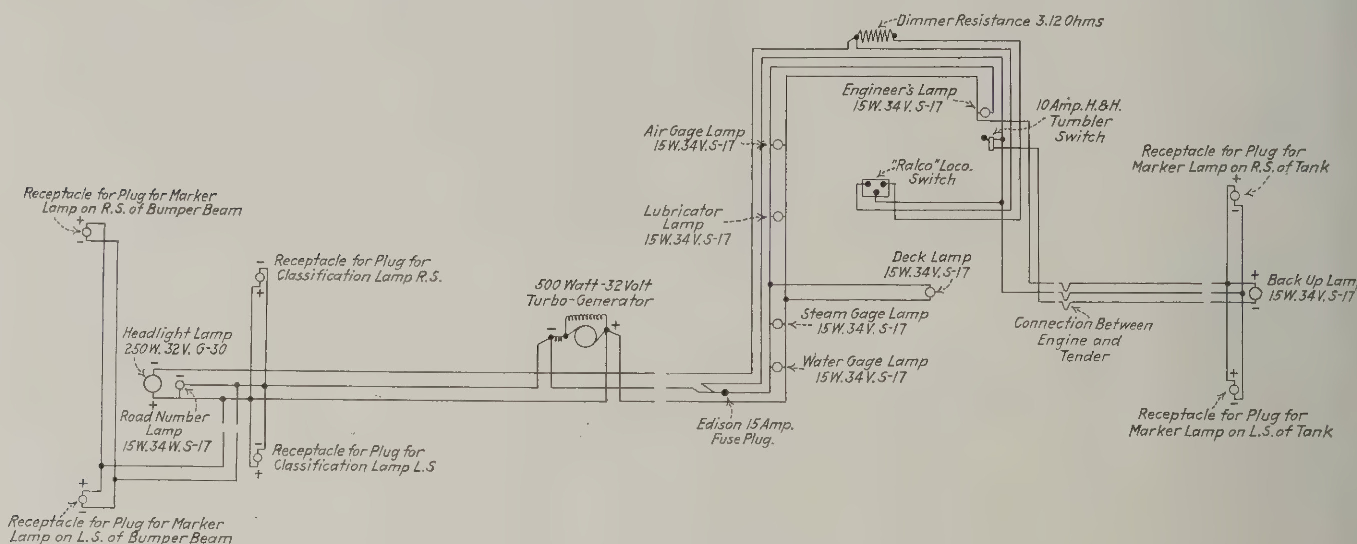


Right Side of Smoke Box Showing Arrangement of Rigid and Flexible Conduit

conduit contains four detachable fittings from which ⅜-in. flexible armored conduit extends to the various gage lamps in front of the boiler. At the end of the transverse conduit the line runs to the rear wall of the

cab, where it turns downward, passing through the floor and terminating in a receptacle which affords the means of extending the circuits to the tender. At the upper end of this vertical conduit, against the roof of the cab is located the engineman's light. Just below this light an outlet box is inserted in the line for the purpose of the opening to which flexible armored conduit would be connected.

It should be noted that the arrangement of the long horizontal run of conduit from the front to the rear of the tender depends upon the type of construction used. In the cast-steel tenders which have been built since the



Wiring Diagram of Locomotive and Tender

housing a switch to control the back-up lamp on the tender. Still further down on this line another branch leads off to the headlight controlling switch which is located between the two windows on the engineman's side of the cab. The fireman's light is located about half way between the rear wall of the cab and the edge of the roof. A piece of ¾-in. conduit extending at right angles from the transverse conduit brings the circuit to this lamp. The dimmer resistance, which is used in connection with the headlight switch is located in the top of the cab and is connected to a circuit leading out from the condulet at the end of the transverse conduit run.

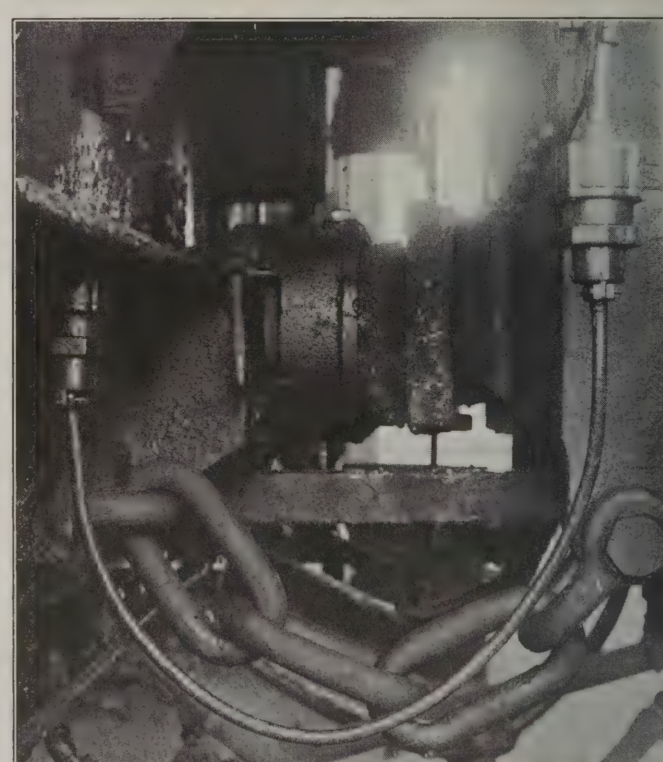
Throughout the entire installation clamps are used to secure firmly the conduit wherever necessary.

Conduit on Tender

The arrangement of the conduit on the tender is comparatively a simple affair since the lighting requirements of the tender are not nearly so exacting as those on the locomotive. From the flexible coupling between the tender and locomotive ¾-in. conduit leads back to the end sill of the tender frame where it turns sharply upward by means of a conduit fitting to the top of the sill. At this point a ¾-in. coupling is used to connect the rigid conduit to a short section of ¾-in. flexible armored conduit which runs to a terminal block in a conduit box located on the back of the tender. From this box the conduit extends to a T-fitting near the top of the tender where it branches out to the right and left. At the end of the shorter horizontal run a receptacle is located for use in connection with proper plug and extension when marker lamps are used. In the longer run a Pyle-National back-up lamp is inserted, but with this exception, the conduit terminates with the same type of receptacle.

The fitting between the vertical and horizontal conduit runs is so designed as to afford means for connecting a headlight when the locomotive is used in transfer or back-up service. Otherwise a ¾-in. pipe plug is used to close

conduit layout has become standard, holes are cored in the frame and the conduit led through these holes. In other instances with built-up tender frames in which plates, cast-steel or wood bumper beams are used, it is



Showing Detachable Connectors and Flexible Conductors Between the Engine and Tender

customary to secure the conduit line by straps which are spot-welded to one of the longitudinal members of the frame. Either the center or outside sill may be used for this purpose.

Wiring of Locomotive and Tender

Practically all of the wiring on the locomotive is No. 14 solid Haberlite wire. On the tender, however, No. 14 solid Kerite or rubber-covered wire is used. Approximately 250 ft. of wire is used on the locomotive and about 125 ft. on the tender. The flexible connection between the locomotive and tender is made of 3 ft. 8 in. length of Duracord comprised of three No. 14 conductors.

The handrail leading forward carries three wires—a negative and a positive from the generator and a third wire for controlling the headlight from the cab. The positive and negative wires are permanently connected to the classification lamps and to the engine number lights. These wires also feed the marker lamps on either side of the bumper beam when such lamps are used. In other words, all of the lamps on the front end of the locomotive are in circuit when the generator is in operation with the exception of the headlight.

Leading into the cab from the generator, the conduit also carries three wires. One of these, the positive, is connected to one terminal of each lamp socket in the cap and on the tender. The second, the negative, enters the fuse block just inside the cab where it divides, one branch passing through a 15-amp. fuse plug and connecting to the other terminals of the cab sockets. The other branch of the negative line is not fused and is tapped into the two switches used in the cab. The first of these is an H. & H. 10-amp. tumbler switch located on the engineman's side of the cab, controlling the back-up light on the tender. The other is a Ralco headlight switch with double contacts which permits the headlight circuit to be operated with or without a dimmer resistance of 3.12 ohms in series.

Rear of Tender Showing Arrangement of Conduit System

Particular attention is called to the breaks in the wiring diagram, of which there are four. These breaks represent the various points at which both conduit and wiring may be readily taken apart either when the locomotive is put through the backshop for repairs or for testing in the event that trouble develops.

There is no higher rank than that of a worker. No title can ever make a loafer a nobleman.

Group Drives vs. Direct Connected Motors

By Louis W. Arny
Secretary, The Leather Belting Exchange

The use of direct connected motors on general machinery is not materially different from their use on machine tools. In many shops, perhaps three cases out of four, a properly designed belt drive is preferable to the individual motor drive for machine tools. Through a term of years the total cost of individual motors and electric wiring, coupled with the maintenance and repairs of this system, will exceed the first cost of properly designed shafting and belting, plus their maintenance and repairs. Moreover, in many cases the individual motor drive means in the end additional complications and expense rather than simplicity and economy.

Motors are better developed and improved than they were ten or fifteen years ago, and there has been radical progress in the improvement and standardization of qualities in leather belting, but perhaps the greatest improvement has been in shafting and bearings, by which the friction load of an ordinary belt drive has been greatly decreased.

The advantage in the use of the direct connected motor is largely in the removal of the obstruction occasioned by the presence of the belt, and the more compact installation which is possible, and possibly the elimination of some bother and trouble resulting from the use of inferior or improper belts. These all are advantages, but in favor of the group drive we have, first, the lower cost of installation. Motors are costly to buy, and in the case of one motor driving a group of, say six machines, as compared with six separate motors on each machine, the original installation cost of the belts may be no more than the annual interest and depreciation costs on the motors, to say nothing of their first cost. This is due principally to the high first cost of the motor. The exact relation would be different in each drive, due to difference in lengths of belts and shafts, but speaking in a general way, with shaft and belt drives of ordinary length, the interest on the investment and the amortization on the motors for one year will go far towards paying for the total cost of the belt and shafting installation.

The capital investment might not be much of a consideration, if there shall result such savings as will justify it, but these savings are not always apparent where the motor is connected directly with the machine. The motor must be of sufficient capacity to start the machine, as well as to keep it in operation after it is started, and it must have sufficient capacity also to be able to handle any overloads which may be placed upon it. This requires that the motor shall be considerably larger than is necessary only to drive the machine when in operation. The margin of safety in these cases will be variable according to the nature of the work to be performed, but it may frequently be necessary that the motor shall be capable of transmitting twice, and sometimes three times its normal load. This accounts for a considerable part of the large investment necessary, and it also means that these motors are running under a load of from 40 to 75 per cent of their normal capacity. Gordon Fox, in discussing this subject, has shown that the efficiency of a motor is dependent upon its percent load, and that this

varies in various types of motors, from as low as 65 per cent efficiency at 25 per cent load to 90 per cent efficiency at 100 per cent load.

On the other hand a good leather belt, in ordinary condition, will transmit power from one pulley to another with an efficiency of 98½ per cent, as has been demonstrated at the research laboratory of the Leather Belting Exchange Foundation at Cornell University. On the apparatus there, in which power is transmitted from a motor to a generator through a belt, it has been found that where 25 hp. is being absorbed by the generator shaft, it is necessary to supply 32 electrical hp. to the motor, a loss of 7 hp. or about 22 per cent. Of this loss, 1½ per cent is in the belt and consists of bendage, windage, creep and slip, the latter being responsible for the larger part of it. It may be assumed that these results are at least as good, and probably better than those attained in general practice, because of the high character of the installation, and the superior care which it receives, and it will be observed that this result is in close accord with the figures given by Mr. Fox.

The motor is an exacting piece of machinery. It must have constant care to keep it clean. Brushes and commutators wear and need renewing, and occasionally an accident will throw upon the motor a load greater than it can handle, and a burned out armature results. Renewals of this character require expensive repairs from skilled mechanics. On the other hand the leather belt has an overload capacity of 100 per cent to meet the shocks of accident. It may be made endless on the pulley by any ordinary mechanic, and when new will require taking up two or three times until it is established in its work, after which it does not need special attention. Belts should be wiped off occasionally, and once in a while they should have an application of belt dressing, but they then can be depended upon to transmit full load regularly every day without any special attention, and for a long time without any repairs. Such attention as is required can be supplied by any mechanic in the plant. In case of accident to the belt the same mechanic can make the repairs, and anybody can make temporary repairs which can keep the machine in operation. A broken belt, as compared with a burned out armature, means that the machine is out of commission but a few minutes, and the work is done by comparatively cheap labor at hand.

The leather belt, too, as compared with the motor, has a long life. Where properly designed, leather belts run indefinitely. There are numerous cases of belts which have run as much as fifty years, and thirty years and forty years are quite common. This applies, of course, to large main driving belts, but even the smaller machine belts run for a good many years, doing their allotted duty at a minimum of cost.

Any comparison of this kind must be based on the presumption of good quality belting. Much has been done to standardize qualities in belting, as well as to improve them, and the new Federal Specifications for Leather Belting, will go much further in this direction. These specifications provide definite and specific tests which accurately will secure the careful buyer a high measure of quality in leather belting. This specification has been prepared through the joint action of committees from the Leather Belting Exchange, and the United States Bureau of Standards at Washington, and is a definite step towards the standardization of quality in leather belting. Leather belting now can be purchased from most of the leading houses of the trade under a guarantee that it complies literally with the terms of these specifications, and those who care to do so, can apply the tests provided therein and determine for themselves the quality of their purchase.

First Automatic Substation for Electrified Steam Road

The New York Central Railroad has contracted with the General Electric Company for an automatic substation installation to be used on its electrified division. The new substation will be located beneath the elevated tracks at One Hundred Tenth street and Park avenue, New York, near the point where they emerge from the Park avenue terminal. While the equipment furnished will provide for full automatic operation, the operator at Mott Haven substation No. 2, about two miles distant, will have the new station under his supervision through pilot wires providing for remote control. This equipment offers an interesting and economical solution to some of the problems of train operation at points where the growth of traffic develops load centers which did not exist at the time of the original installation.

The equipment will consist of a 2,000-kilowatt motor generator set operated directly from the 11,000-volt transmission line and with the generator tied in to the 660-volt third rail system.

The set may be floated on the line all day or may be closed down during the periods of light traffic at the discretion of the operator at the Mott Haven Junction substation. To start the station, he simply operates a control switch and the automatic control in the new substation takes care of starting the motor generator set and bringing it on to the line. An operator in the station at Mott Haven may also follow the output of the machine and its load conditions at any time of the day. From his knowledge of train movements he is in a position to know when the set may be unnecessary and the indicating equipment on his meter panel gives an additional check on the line load.

In the event of a service interruption due to failure of the high tension supply, the automatic station will of itself shut down and be ready to come on to the line again with the resumption of service from the power station.

The automatic station control is laid out so as to present the characteristics of a constant current generator. The control can be adjusted so that the generator will supply continuously any value of current below the rated output for so long as the operator may anticipate the concentration of load or for such a period as is possible without overheating.

According to a report presented to the Italian parliament, the Italian railways at present possess 6,436 steam and electric locomotives and they have under construction 475 steam and 82 electric locomotives. Grants have been made for the construction of 120 locomotives and another 75 will shortly be ordered. Within the next five years 600 steam locomotives will be scrapped.

Principles of Car Lighting by Electricity

A Discussion of Various Methods and Tools Used in Locating Troubles in Generators and Other Equipment

By C. W. T. Stuart

At large and congested railroad terminals it is not an easy matter for an electrician to persuade a train director to drill a car out of a regular run for electrical repairs. Usually, if the generator fails, the removal of the belt is suggested, or, in case of a total failure, that is, both generator and battery, the emergency candle lamps are pressed into service. This, no doubt, assists the train director to keep trains moving on time, but on the other hand, it gives the car lighting department a lower percentage of efficiency.

For example, the efficiency of electric car lighting is figured on the number of car arrivals with lights o. k.

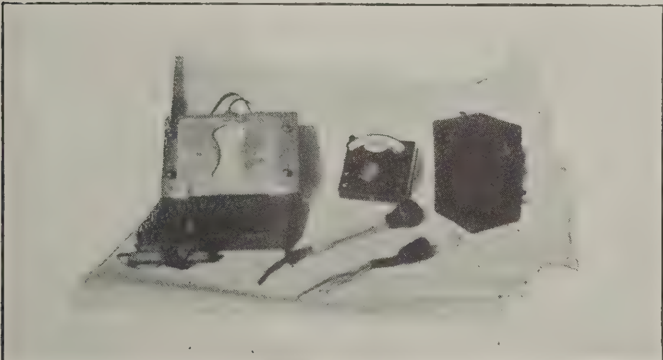


Fig. 1—Group of Testing Instruments Consisting of a Voltmeter, Ammeter, Magneto, Hydrometer and Test Lamp

over the total car arrivals. If a car arrives at a terminal with a defective car lighting equipment and is drilled out of service and repaired, the failure list would only show one failure due to that particular defect, but if this same car is not drilled out of service and repaired, until after it has made ten trips, then the failure list would show ten failures due to a single defect in this individual car lighting equipment.

Therefore the electrician at a terminal, in an effort to keep down the number of car lighting failures, must have some quick method of not only locating trouble, but also of making repairs.

A car lighting equipment consists of a number of parts connected by wires and operating as a unit. Each part has its function and therefore may be tested individually. The five instruments that are used in testing are magneto, test lamp, voltmeter, ammeter, and hydrometer. See Fig. 1.

The cadmium test piece and thermometer used in testing battery capacity have been described and demonstrated in a previous article and will be omitted in this article to avoid confusion.

Most inspecting and testing is made with the car standing, when the generator is inoperative. In this position, the current to the lights is furnished by the storage battery. Upon the arrival of a car, the inspector switches on the lighting circuits thereby placing a discharge load on the battery. He then inspects the individual lamps and fans in the various circuits throughout the car.

By this time, the battery voltage has had an opportunity to settle and the inspector takes a voltage reading across the two battery wires and the two lighting circuit wires at the switchboard.

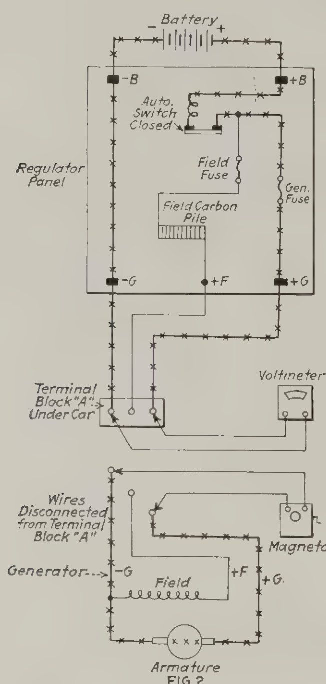
The battery voltage reading at this point for a 16 cell lead battery should be approximately 2 volts per cell or a total of 32 volts, and for a 25 cell Edison battery approximately 1.28 volts per cell or a total of 32 volts, when the battery is fully charged and with fair sized lamp load. The lamp voltage on cars equipped with a lamp regulator should read approximately 2 volts less than the battery voltage. If it is more the lamp regulator is out of adjustment (and should be adjusted by placing the battery on charge). The inspector then inspects the generator regulator coils and if they are warm it is an indication that the generator has been operating and if the generator belt and pulleys are o. k. he passes on to the next car.

The yard electricians have more of an opportunity to inspect the equipment when the trains are backed into the yards for cleaning, ice water, etc. A yard electrician receiving a car with a defective lighting equipment would first turn on all lighting switches and take a voltage test at the switchboard. If the battery voltage is o. k. and the lamps do not burn then he proceeds at once to find the trouble on the lighting circuits. On the other hand, if the battery voltage is low he would proceed to the battery compartment and take an individual cell voltage and hydrometer reading and examine the battery fuses and connections. Not finding any defect in the battery other than a discharged condition, the next step would be to place the battery on charge and inspect the generator and regulators. Trouble on a generator or regulator can usually be located by giving the generator what is known as the motoring test. This test consists of removing the belt from the pulley and operating the generator as a motor from the battery by closing the automatic switch by hand. The machine is started with full field and is brought up to the maximum speed by increasing the field resistance with the carbon pile on the regulator panel. At maximum speed the field resistance is suddenly reduced to a minimum and the automatic switch released. The momentum of the armature revolving in a strong magnetic field causes the automatic switch to close automatically indicating that the machine is acting as a generator. The ground test of the entire system is taken by grounding first the positive and then the negative brushes of the generator to the generator frame with a small piece of wire while the lights are burning and the generator turning over as a motor. The motoring and ground test will sometimes, but not always, locate the trouble.

If the motoring test fails to show the source of trouble,

then the two circuits, that is, the armature and field circuits should be tested individually.

The armature and main generator circuit is connected in series with the battery circuit and may be traced through the regulator, generator, and connecting wires. A quick but crude way of testing this circuit is to remove the generator fuse, close the automatic switch and then flash the circuit by rapidly inserting and removing the generator fuse. An arc upon removing this fuse will



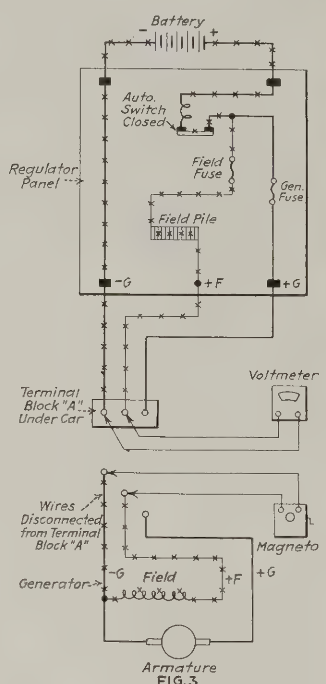


Fig. 2—Testing Armature Circuit with Voltmeter and Magneto from Under Car

Fig. 3—Testing Field Circuit with Voltmeter and Magneto from Under Car. Circuits Through Which Magneto and Voltmeter Current Pass Are Marked with Crosses

indicate a closed circuit and vice versa. This operation will blister the fuse clips therefore it is well in making this test to have a small knife switch mounted on a set

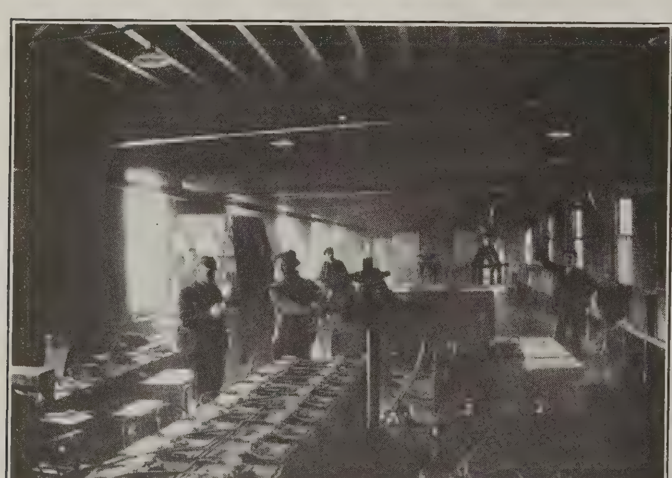
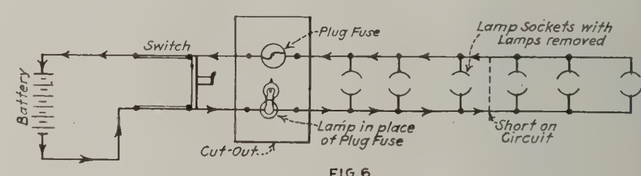


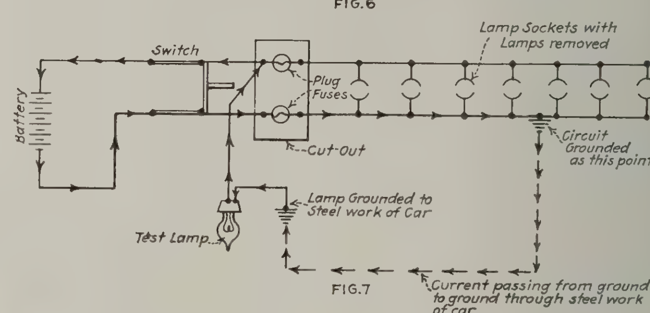
Fig. 4—General View of Battery Repair Room

of fuse blades arranged in place of the generator fuse so that the switch blades take the arm instead of the fuse clips. Upon inspecting an armature circuit for defects not the following: That the generator fuse is not blown, that all connections are tight, commutator is clean and brushes making good contact. If the commutator is rough and burned, it is usually due to either short brushes, dirty brushes sticking in the brush holders or

Fig. 5—Lifting Irons Carrying Set of Edison Batteries

high mica between the commutator segments. Flat spots in the commutator are usually caused by open armature coils. Also note that the armature is not grounded by





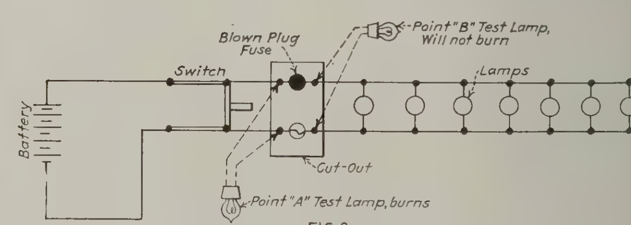


Fig. 6—Locating Short Circuit by Having a Lamp Burning Through the Short as an Indicator

Fig. 7—Locating Ground by Having Test Lamp Burning Through Ground as an Indicator. Path of Current Shown by Arrows

Fig. 8—Locating Open by Use of Test Lamp

testing with the magneto from the commutator to the armature shaft or armature core.

The field circuit may be traced through the regulator, the generator and the connecting wires. This circuit includes the field carbon pile, field fuse, and field coils. A quick way of testing this circuit is to remove the generator fuse, close the automatic switch, and then remove the field fuse. If there is an arc at the fuse clips

when the field fuse is removed, it will indicate a closed circuit and vice versa. Upon inspecting a field circuit for defects the following should be noted:

That the field fuse is not blown.

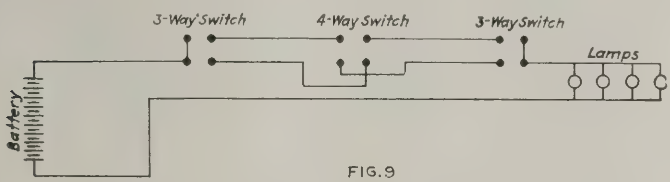
That all connections are tight.

That the field carbon discs are clean and that none are missing.

That each field coil is producing a magnetic field of the correct polarity.

The last named may be ascertained by connecting, with the armature removed, and the field coils energized, the adjacent pole shoes with a piece of bar iron. Like poles will repel each other while unlike poles will attract, therefore if the field coils are connected properly the adjacent poles will be unlike and there will be a strong attraction when connected through the iron test piece.

In an effort to locate a ground or open in a field or armature circuit, the circuits may be divided into two sections at the terminal block under the car. The three generator wires may be disconnected from the terminal block and the circuits tested to the terminal block with a voltmeter, and from the terminal block through the interior of the generator with a magneto. To make this test, disconnect the three generator wires at the terminal block under the car, close the automatic switch and take a voltage test at the terminals across the field and generator wires, as shown in Figs. 2 and 3. A voltage reading at this point indicates that the armature and field circuits are closed through the generator regulator and connecting wires to the terminal block and vice versa.



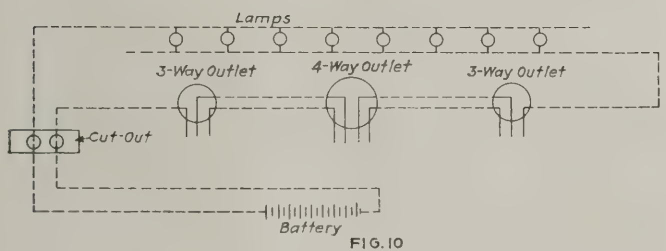


Fig. 9—Diagram of Three and Four Way Circuit

Fig. 10—Diagram of Three and Four Way Circuit Showing Lamps Overhead, Battery Under Car and Wires Protruding at Switch Outlets

Then the field and armature circuits inside the generator may be tested with a magneto across the three wires that are disconnected from the terminal block and lead into the generator, as shown in Figs. 2 and 3. A ring of the magneto across the wires at this point will indicate a closed circuit and vice versa.

In locating trouble on a car lighting equipment, the lifting coil, the voltage regulating coil, and the lamp voltage regulating coil circuits should be tested also. Each circuit includes a resistance unit in series with the coil and by energizing the circuit, accomplished by closing the automatic switch, turning on the lamps, etc., a closed circuit will be indicated by the heating of these respective resistance units.

A cell voltage reading frequently indicates a dead cell, but that does not always mean that such a cell is defective because the efficiency of the individual cells in a battery

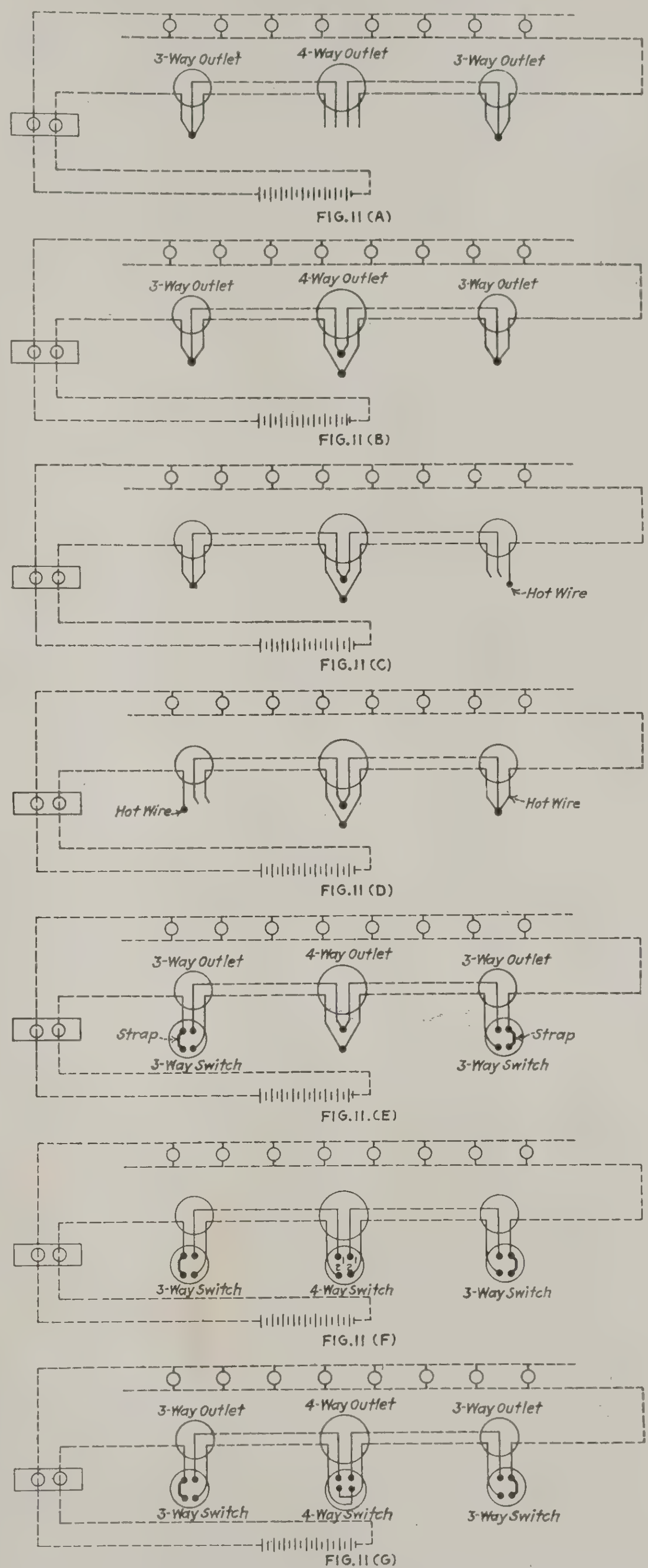


Fig. 11—(A) Tie the Three Wires Together at Each Three Way Switch. (B) Tie the Wires at the Four Way Outlet in Two Pairs. (C) Pick Up Hot Wire at Three Way Outlet. (D) Pick Up Hot Wire at Second Three Way Outlet. (E) Connect Wires to Three Way Switches, Connecting the Hot Wire to the Strap at Each Switch. (F) Connecting Wires to Four Way Switch. (G) If Switches Do Not Operate Correctly, Cris-Cross One Pair of Wires at the Four Way Switch.

vary, that is, one cell will reach a state of full charge or discharge ahead of another, etc. Therefore, when an individual cell voltage reading of a lead battery shows five cells dead and the others reading around 1.8 volts per cell, would not necessarily mean that these five cells were defective. It may have been that this particular battery

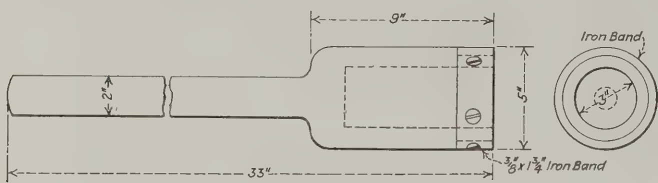


Fig. 12—Wooden Leg for Use in Removing and Applying Armatures

was permitted to remain in a discharged condition for some time and that these five cells were sulphated heavier than the others, thereby requiring the additional charging to break down the sulphate. The proper thing to do in this case would be to place the battery on charge for a time and then take another cell voltage and hydrometer reading on discharge. If the cell voltage did not rise during the charge then there is no doubt that the cells are defective and should be repaired.

Defective cells should be taken to a battery repair room, as shown in Fig. 4, the covers taken off and the elements removed from the tanks. Sediment is washed out of the

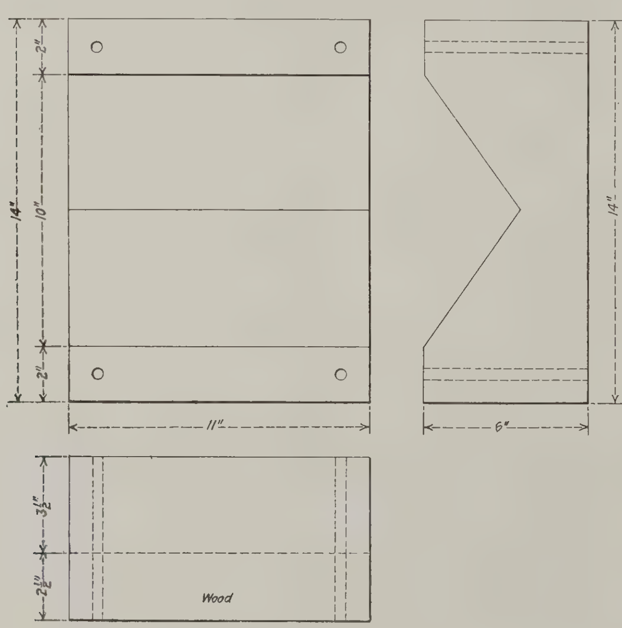


Fig. 13—Block for Supporting Armature on Truck and Work Bench

bottom of the tank. Positive and negative plates are also washed and separaters and insulators should be inspected and renewed if found defective. The plates if buckled should be straightened and the cells reassembled. In an emergency a defective cell may be shunted out of circuit without having any serious effect other than lowering the voltage to the lamps when the car is standing and current is being supplied from the battery. This, however, should not be practiced when it is possible to change the crate.

A dry cell, that is, one from which the acid had leaked out through a small hole in the lead tank, would open the battery circuit. In this case, upon switching on the lighting circuits the lamps would not burn due to the circuit being open at the dry cell. The cell voltage reading in this case would be normal until you reached the dry cell and then you would get a full voltage reading, because instead of placing the voltmeter across one cell as intended you would have it across the opening in the battery circuit. It is therefore very important when taking a cell voltage reading in an effort to locate a dry cell that the voltmeter leads are connected to the high and not low scale of the voltmeter.

Should a battery arrive with an open circuit due to a wire connector breaking off at a battery post, it may either be repaired in the battery house with the lead burning outfit or at the car with the burning arc which will be described further on in this article.

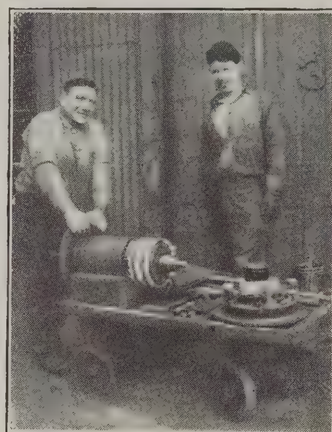


Fig. 14—Care Should Be Used in Transporting Armature on the Truck

A cell voltage reading of an Edison battery would be taken in a similar manner to that of the lead battery, but when a defective cell is found it is replaced by one from stock and forwarded to the Edison factory for repairs. The care of the Edison battery in the railroad battery repair room is limited to cleaning, painting, oiling, flushing, renewal of solution and charging. Fig. 5 shows a set of Edison car lighting batteries in a battery repair room in the act of being painted by the dipping process.

Testing for Grounds, Shorts and Opens

Trouble on a lighting circuit is usually, a short circuit, a grounded circuit or open circuit.

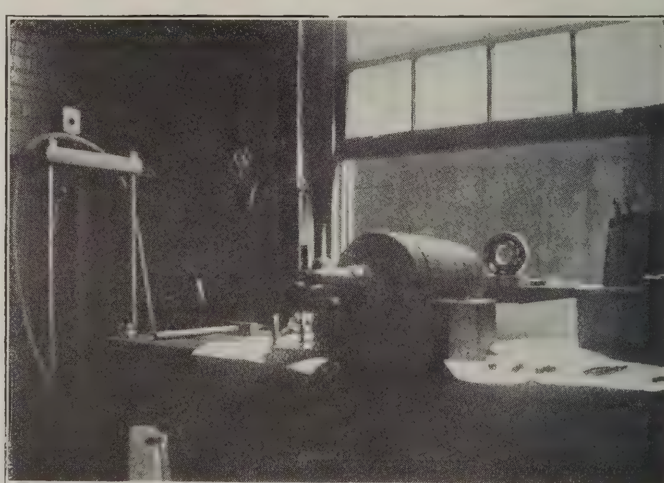


Fig. 15—A Wood Block Makes a Good Armature Support on the Work Bench

Short Circuit: A method of locating a short on a lighting circuit is as follows:

First—Remove the lamp from each socket in the circuit.

Second—Screw a lamp in the branch block in place of the blown plug fuse.

Third—Turn the circuit switch to the "on" position and the lamp will burn by receiving the flow of current through the short in the circuit as shown in Fig. 6.

Fourth—Disconnect each fixture and branch of the circuit and the lamp by failing to burn will be an indication that the short has been removed from the circuit.

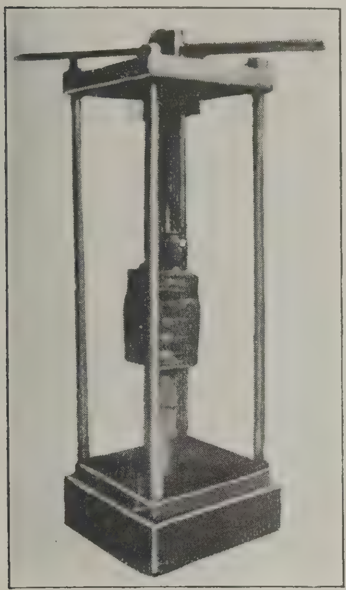


Fig. 16

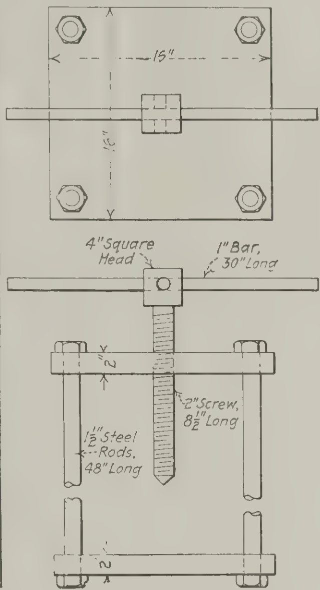


Fig. 17 (a)

Figs. 16 and 17(a)—Armature Hand Press

Grounded Circuit: A method of locating a ground on a lighting circuit is as follows:

First—Remove the lamp from each socket in the circuit.

Second—Connect a test lamp at the switchboard. Connect one side of the lamp to the side of the circuit that is not grounded and ground the other side of the test lamp to the steel work of the car.

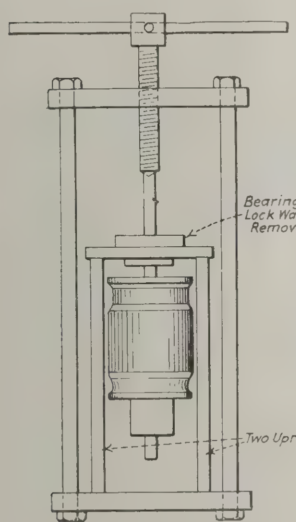


Fig. 17 (b)

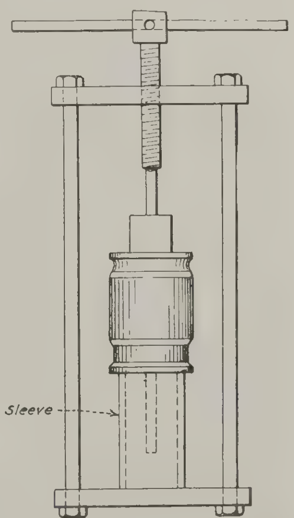


Fig. 17 (c)

Fig. 17(b)—Pressing Pulley End Bearing Off the Shaft
Fig. 17(c)—Pressing Shaft from Armature

Third—Close the lighting circuit switch and the test lamp will burn by receiving the flow of current through the ground in the circuit as shown in Fig. 7.

Fourth—Disconnect each fixture or branch of the circuit, and when the grounded section is removed from the circuit, the test lamp will indicate same by failing to burn.

Open Circuit: A method of locating an open in a lighting circuit is to test the circuit at various points throughout its entire length, starting at the switchboard with a test lamp.

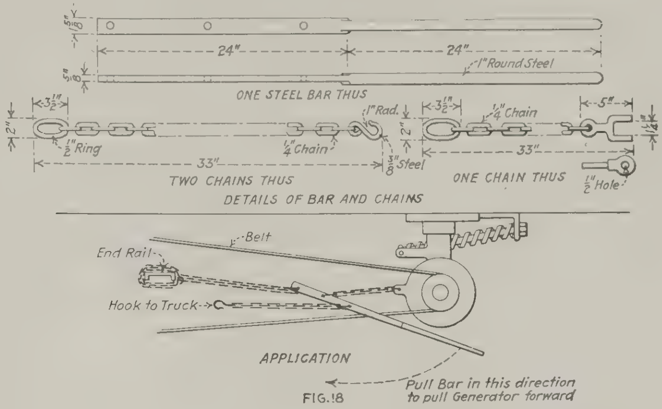


Fig. 18—Device for Use in Removing and Applying Axle Generator Belts to Body Hung Generators

The lamp burning when connected across the circuit at *A*, Fig. 8, will indicate that the circuit is closed to that point. If the lamp burns when connected at *A* and fails to burn when connected at *B* then the circuit is open at the cutout, possibly a blown plug fuse or a broken wire. In like manner an open can be located at any point throughout the circuit.

Testing and Connecting a Three- and Four-Way Lighting Circuit

The three- and four-way circuit has been introduced to train lighting within the past few years and has been a stumbling block to many a car lighting man. The wiring scheme as shown in the diagram of a three- and four-way circuit, Fig. 9, is easy to understand, but the difficulty is experienced in testing out and connecting the switches when the wires are concealed in the conduit with only the ends projecting at the switch outlet boxes, as shown in Fig. 10.

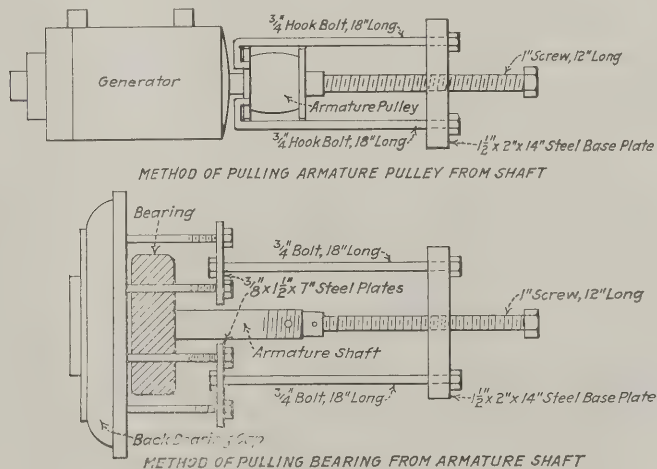


Fig. 19—Pulley and Bearing Puller

A method of procedure in connecting the switches to

such a circuit is shown step by step in the diagrams *A, B, C, D, E, F, G,* Fig. 11.

Start with all three switches disconnected, as shown in Fig. 10:—*First Step*—Connect the three wires together at each three-way outlet as shown in diagram *A*, Fig. 11.

Second Step—Connect the four wires at the four-way outlet into two pairs, selecting the pairs that close the circuit and light the lamps, as shown in diagram *B*.

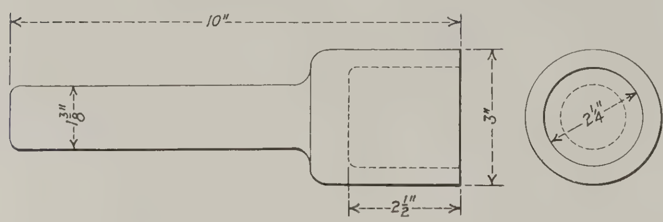


Fig. 20—Armature Pulley Driving Iron

Third Step—Pick up the hot wire at one of the three-way outlets. The hot wire will be the one that will light the lamps when connected to either of the other two wires, as shown in diagram *C*.

Fourth Step—In like manner pick up the hot wire at the other three-way outlet, as shown in diagram *D*.

Fifth Step—Concert the two three-way switches, as shown in diagram *E*, connecting the hot wire to the strap of each switch.

Sixth Step—Mark the upper two connections on the four-way switch No. 1, and the lower two connections mark No. 2, and connect one pair of wires to the connections No. 1 and the other to connections No. 2, as shown in diagram *F*.

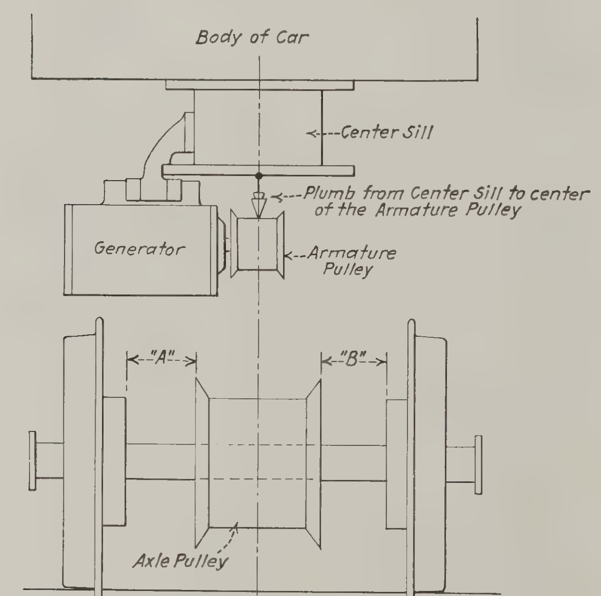


Fig. 21—Lining Up Axle Pulley on a Body Type Generator

Seventh Step—With the four-way switch connected, as shown in diagram *F*, it can be plainly seen that on one point of the four-way it would be impossible to close the circuit from either of the three-ways. This can be corrected by criscrossing one pair of wires, either pair, No. 1 or pair No. 2, at the four-way, as shown in diagram *G*. The three- and four-way switches will then be connected correctly. If by chance one pair of wires were crissed in the operation of the sixth step, then the seventh step would be unnecessary.

Practical Stunts, Tools, Etc.

Tool for removing and applying armature.—Removing and applying an armature to a generator under a car without damaging the commutator is rather a difficult job, therefore some tool should be available with which the commutator end of the armature can be held steady as the armature passes in and out through the end of the housing.

A tool for this particular job is shown in Fig. 12 and is nicknamed a "wooden leg," because of its resemblance to one. It is slipped over the commutator end of the armature shaft and is of sufficient length to allow for the passing of the armature through the end of the housing with one lift.

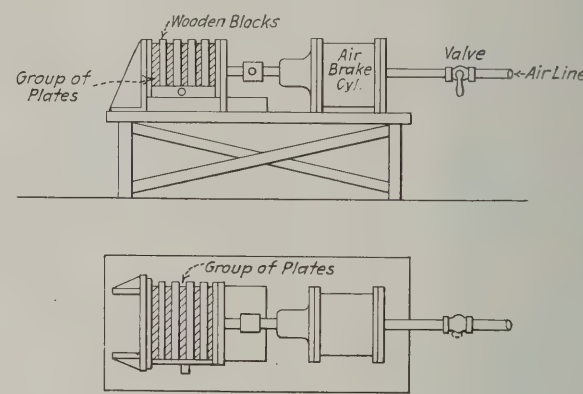


Fig. 22—Press for Lead Battery Plates

Protecting armature and commutator on truck in transit from car to shop and on bench in shop.—Rough handling of armature is rather expensive and can easily be avoided. Instead of one end of the armature resting on the corner of the commutator in the path of rolling bars, or other tools, while in transit or in the workshop, a truck or work bench should be equipped with some sort of carrier. Fig. 13 shows a block that may be used to support the armature on a truck, as shown in Fig. 14, and on the work bench as shown in Fig. 15. It may also be noted in Fig. 14 that a canvas band protects the commutator. This canvas band

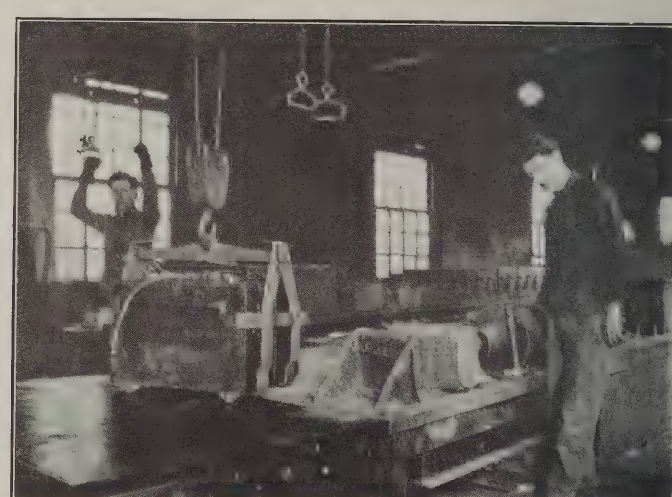


Fig. 23—View in Battery Room Showing Plate Press and Lifting Iron Carrying Two Crates of Lead Batteries

will protect the commutator from being scarred in handling and can be quickly applied and removed.

Press for Removing Armature Shaft and Bearings

The pulley end bearing is usually forced upon the armature shaft under pressure and the shaft forced in the armature in like manner. Therefore when it becomes necessary to remove the bearing from the shaft or renew a shaft some device is needed that will perform the work without damage to the armature, shaft or bearing. Figs. 16 and 17 show a hand press that will remove and apply these parts. It is constructed from two 2 in. x 16 in. x 16 in. steel plates, four 1½ in. x 48 in. steel rods, one 2 in. x 8½ in. screw with 4 in. square head, one 1 in. x 30 in. steel handle bar and eight 1¼ in. hexagonal nuts.

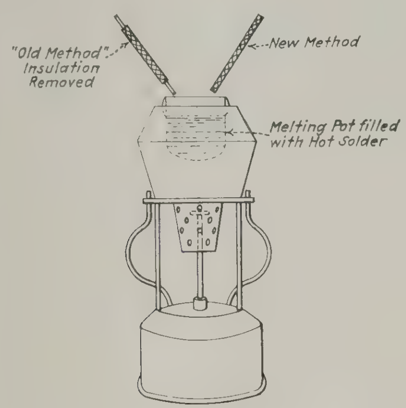


Fig. 24—Method of Tinning Wire Connectors Before Removing the Insulation

To remove a bearing from the shaft.—To remove a bearing from the shaft, suspend the armature with pulley end head complete from head flange upon two wooden uprights, after removing thrust washer from armature shaft. Then by turning the 2 in. screw, Fig. 16, armature and shaft will be pressed in a downward direction free from head end bearing. Care should be exercised to have the two uprights the same length and screw and armature shaft in perfect line before pressing off bearing, otherwise there is danger of bending armature shaft.

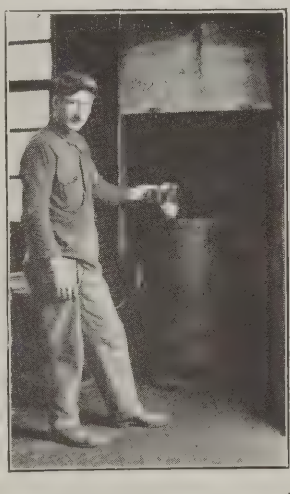


Fig. 25—Battery Compound Melting Pot

To remove armature shaft from armature.—Invert the armature in the press, as shown in Fig. 17(c), resting core of armature upon sleeve. Then by removing thrust washer and turning the screw the armature shaft will be pressed in a downward direction free from the armature.

The armature shaft and bearing can be replaced in like manner by using sleeves that fit over the shaft. This stunt is a time saver and eliminates the danger of damage possible with the old method of sledging or bumping.

Device for use in removing and applying axle generator belts to body hung generator.—When an axle generator belt is found to be missing within a few minutes of train time, there is no time to be spared. If the generator is a truck suspended one, it can be easily pried forward with a bar and a new belt applied. Suppose, however, the generator is not truck suspended but, instead, it is a body hung machine. In this latter case a train detention is apt to result, unless some divice is at hand which can be easily applied to pull the generator forward and quickly put on a new belt.

Various types and makes of generators are now suspended from the car body, therefore the device must be one that can be used universally. An arrangement of this type which recommends itself by its simplicity, consists of a bar and three chains, Fig. 18. One of these chains is attached to the truck end rail and a second chain to the generator. The bar is then moved forward, as shown by the dotted line, Fig. 18, which movement pulls the generator forward. The third or remaining chain comes into play when the generator has been pulled forward. This chain serves to hold the machine forward while the belt is being applied.

This device is a great time and labor saver and may be used on any type of body hung generator. When equipped with this outfit one man can apply or remove a generator belt with ease so that a car detention due to a missing belt is a rare occurrence.

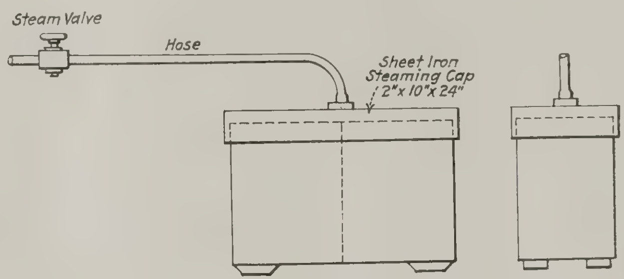


Fig. 26—Steam Caps for Removing Battery Covers

Pulley and bearing puller.—Armature pulleys, in addition to being driven over the tapered armature shaft, at times rust, making it a rather difficult job to remove them. The old method of removing them with a pinch bar, hammer and chisel was rather expensive because in most cases when the pulley was a tight fit the flanges were broken or the shaft bent.

A device for removing armature pulleys is shown in Fig. 19. It consists of an iron base plate 1½ in. x 2 in. x 14 in., two ¾ in. bolts and a 1 in. x 12 in. machine screw. This same device with the addition of two plates ⅜ in. x 1½ in. x 7 in., fitted to the back bearing cap, as shown in Fig. 19, will act as a bearing puller.

Pulley driving iron.—The armature pulley is keyed to the armature shaft with a tapered fit. Therefore, if the pulley is not driven home when applied, it will gradually work loose and result in the key cutting away the armature shaft and bore of pulley.

The old method of driving the pulley home by hammering on the pulley flanges has passed. It was possible to drive the pulley in place with a hammer when the generators were truck suspended and had pulleys with straight flanges. But the new body hung machines are equipped with tapered flanged pulleys and to attempt to drive them in place by hammering on the tapered flange is sure to result in the fracture of the flange.

A driving iron, as shown in Fig. 20, is a valuable tool

for this particular work. It fits over the nut on the pulley end of the shaft and delivers the shock of the hammer's blow to the heavy web of the pulley.

This prevents the possibility of breaking the flanges and the fact that the blow is distributed evenly around the circumference of the pulley bore eliminates the possibility of bending the armature shaft.

Lining up axle with a body suspended generator.—To line up the axle pulley with a body suspended generator plumb from the bottom of the center sill to the center of the armature pulley, as shown in Fig. 21, and note the relation of the center line of the pulley to the center line of the sill. If the center line of the armature pulley is 1 in. off the center line of the sill, then the axle pulley should be located 1 in. off the center of the axle. The relation of the center line of the pulley and the center line of the axle may be checked by measuring the distance *A* and *B*, Fig. 21.

Press for lead battery plates.—The press, Fig. 22, is designed for straightening buckled lead battery plates. It is made from material which is not expensive and which can be found in nearly every railroad shop. The essential parts of the press are an air brake cylinder, an iron base plate and two iron jaws, mounted upon a bench. One jaw is fixed to the base plate, while the other jaw is connected to the end of the piston rod and slides over the base plate, guided by two projecting lugs. The air which operates the press is controlled by a valve located in the air pipe feeding line at one end of the cylinder.

Fig. 22 and 23 illustrate the machine in operation with a group of plates under pressure. Wooden blocks are used as liners between the plates. The advantages of this press are the saving in time over ordinary methods and the effect of the slow steady pressure applied to the plates, which forces them back to their original shape

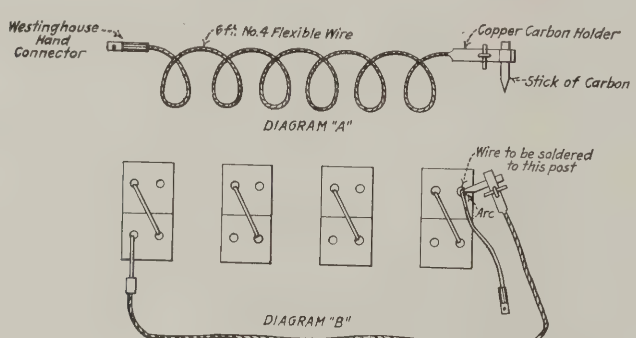


Fig. 27—Emergency Welding

without the damage which results from hammering or other crude methods.

Wire connectors for car lighting batteries.—Instead of skinning the ends of the wire and then tinning it, it is advantageous to tin the ends before removing the insulation. To make a car lighting battery lead take a piece of insulated wire of the proper length and dip the ends first into the soldering flux and then into a melting pot of solder. See Fig. 24. Allow it to cool and remove the insulation.

This has several advantages over the old method. The heat of the solder loosens the rubber insulation from the wire and makes it easy to remove and in case of flexible wire the strands are soldered together, making it impossible to separate them while removing the insulation.

Removing and Applying Battery Covers

Battery covers when applied are sealed with a compound to prevent the slopping of the acid. The compound is melted in a gas-heated pot, as shown in Fig. 25. The compound when hot is dipped from the heater and poured around the edge of the cover and allowed to cool. When hard it seals the space between the cover and the tank.

To remove the cover a steam cap is placed over the crate, as shown in Fig. 26. This cap measures 2 in. x 10 in. x 24 in., and is made of sheet iron. After a few minutes of steaming the compound softens and can easily be removed.

Emergency Welding.—Take a piece of No. 4 wire six feet long and attach a female Westinghouse battery hand connector to one end, and a copper carbon holder to the

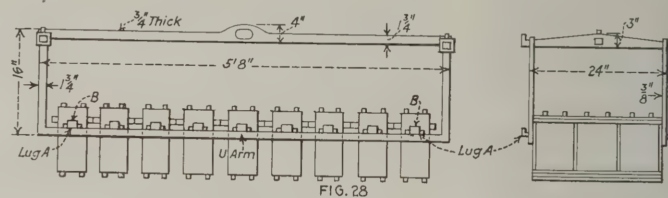


Fig. 28—Lifting Irons for Edison Battery

other end. Then place a piece of stick carbon about four inches long in holder. See diagram *A*, Fig. 27. This combination can be used for repairing an open circuit in a battery when the wire is broken off close to the terminal of the battery.

This connector is a practical time saver in a case of emergency, say when a car arrives at a terminal in a train in through service having a ten-minute lay-over, with an open in battery as above described. Instead of the present way of cutting out the entire crate, meaning a four-volt drop in battery, the wire could be permanently welded to battery terminal in a very few minutes, as follows:

Pull crate with broken lead out on battery box door far enough to reach post the wire is to be attached to, then place connector to close circuit of three adjoining crates, arranging so carbon point will close circuit through post in which lead is to be soldered. See diagram *B*. Fig. 27. Then by drawing an arc between point of carbon and post the lead can be readily welded in place.

Lifting Irons for Edison Batteries.—When cleaning Edison batteries it is very important that the bottoms of the cans should be clean and dry, as well as the top and sides. By the use of the lifting irons shown in Fig. 28, the battery can be lifted by the crane and the bottoms well cleaned. Considerable time can also be saved by moving the batteries from the drip rack, Fig. 5, to the bench and from the bench upon the truck, with these irons. The old method of sliding the crates when loading or unloading them from a truck, is undesirable, as there is danger of breaking the skids or pulling the wire connectors out of shape. Small wire hooks will hold the handles up and these irons can be readily placed under them. The details of the irons are shown in Fig. 28. Note that the lugs *A* on the U-irons slip into the end crate handles, as shown at *B*, thereby preventing shifting. The two long U-irons are punched from 3/8 in. boiler steel but the three top hangers are forgings. Fig. 23 shows another type of lifting iron carrying two crates of lead batteries.

A Multiple Unit Train on the New York, Westchester & Boston

Some Service Records of Electric Equipment

A List of Unusual Things Accomplished by Railroads with Electric Motor Power

By Homer K. Smith
Railway Engineer, Westinghouse Electric & Manufacturing Company

THE Long Island was the first steam railroad in the United States to substitute electric for steam power on a larger scale, the change being made on this road in 1903. Multiple unit cars with two 600-volt d.c. motors and a third-rail contact system were adopted. Since electrification this road's passenger traffic has increased nearly 400 per cent. The freight traffic has increased nearly 200 per cent, and the earnings have increased approximately 200 per cent. There are 220 miles of electrified track and over 700 cars, of which approximately 80 per cent are motor cars, now in operation. The annual passenger traffic is over 600,000,000 passenger miles. Some idea of the dependability of these large motor cars is shown by the fact that during certain hours the schedules call for over 95 per cent of the equipment.

New York, New Haven & Hartford

The New York, New Haven & Hartford, with approximately 550 miles of electrified track, has more connected electrified trackage than any other system in the world. In 1918 the passenger traffic density on this road was second only to that of the Long Island. Single phase electric locomotives are used for the through fast passenger and some of the local passenger service, for the fast freight service and for switching service. Multiple unit cars are used for some of the local passenger service.

In 1921 the electric passenger locomotive averaged 33,000 miles per locomotive failure and the average detention per failure was 18 minutes. The mileage per locomotive was nearly 60,000. During the same year, with a comparatively light freight traffic, the freight locomotive mileage per locomotive failure was approximately 22,500. These locomotives frequently made two round trips between the Harlem river and New Haven in 24 hours. This represents a mileage of 272. Under steam operation in this section the daily locomotive mileage was from 100 to 120.

The New Haven has in operation 16 electric switching locomotives. For a period of seven years—1915 to 1921 inclusive—these locomotives were in actual service over 70 per cent of the total time and during 1916 they were in actual service over 77 per cent of the time. These locomotives are operated 24 hours per day and they consistently make 140 miles a day (based on 6 miles an hour). It is a matter of record that the use of these electric locomotives has resulted in a coal saving of 65 per cent of that required for steam operation of this service and they have replaced steam locomotives in the ratio of 2 to 1.

A striking illustration of the adaptability, flexibility and reliability of the New Haven electrification for meeting heavy traffic emergencies was demonstrated on November 20, 1920, this being the occasion of the annual Yale-Harvard football game. From 8:00 a.m. until 11:00 a.m. 44 special trains were dispatched from New York to New Haven in addition to the regular trains. During this period trains were dispatched from the Grand Central Terminal at intervals of 10 minutes. The same day 45 extra trains were operated in the opposite direction. The 89 extra trains carried approximately 70,000 passengers, and all of these trains departed and arrived practically on schedule.

Pennsylvania, New York Terminal

In 1910 the Pennsylvania Railroad placed in service on its electrified extension into the New York terminal 31, 600-volt third rail locomotives. These handle all of the main line passenger traffic into and out of New York terminal, and from November, 1910, to 1918 they made a total of 9,508,765 miles with a total of 121 engine failures, or an average of 78,600 miles per detention on ac-

count of locomotive trouble. During one year there was a total train delay due to failure of motive power of only 55 minutes. These locomotives are now averaging about 4,500 miles per month and their maintenance is extremely low.

Norfolk & Western

The Norfolk & Western electrification represents the most severe requirements that electrification has yet been called upon to perform. This road was the first to substitute electric for Mallet locomotives for mountain grade service when its electrification extending from Bluefield to Vivian, a route distance of 30 miles, was put into operation in 1914. The electrification zone has since been extended west approximately eight miles to Farm. This line is double tracked throughout except for the 3,000 ft. Elkhorn tunnel. There is a considerable mileage of third track, side and yard tracks and various branch or spur tracks to numerous coal mines along this section.

With steam operation trains of approximately 3,250 tons were hauled up the Elkhorn grade with three most modern Mallet locomotives at a speed of seven miles per hour. Two 300-ton electric locomotives haul the same trains on this grade at a speed of 14 miles per hour. Twelve electric locomotives were purchased to replace 24 Mallets but by the time electric operation was started traffic had increased so that 33 Mallets would have been required. Since electrification was inaugurated the volume of traffic has increased enormously but the twelve original electric locomotives handle the service.

In a service where the average main line haul is short and where there is considerable coal mine setting out and gathering service, as well as pusher service, these electric locomotives consistently do more than 100 miles per day. During the year 1920 they made an average mileage of 37,820. Because of there being so much switching service, the actual mileage was undoubtedly more than shown by the above record. The steam locomotives formerly used in this service averaged approximately 60 miles per day.

The increased train speed and reduction in road delays obtained with the electric locomotives has, of course, greatly increased the track capacity. It has been stated by Norfolk & Western officials that this electrification has at least doubled the track capacity—as compared to steam operation.

A recent notable achievement on this electrification was the handling of 90,000 tons of freight eastbound over the Elkhorn grade, and through the single track tunnel at the summit of this grade, in a single day.

New York, Westchester & Boston

An example of the successful application of heavy alternating current motor cars to dense traffic in exacting suburban service is that of the New York, Westchester & Boston; local and express service from the Harlem river station of the New York, New Haven & Hartford trains make a schedule of 22 miles per hour with a stop every mile. The express train schedule speed is 37 miles per hour with an average distance of 2½ miles between stops.

These equipments have proven their reliability in all kinds of weather. During the heavy snow storms of 1919-20, when the service on many steam roads was seriously demoralized, the operation of the suburban service on this road was 100 per cent perfect. In 1919 the average mileage per car was over 42,000 and the average car mileage per minute of delay was over 2,700.

Pennsylvania, Philadelphia Suburban Service

The Pennsylvania suburban service from the Broad street terminal in Philadelphia to Paoli and Chestnut Hill represents what is undoubtedly the most severe, congested traffic problem in modern railroading. The Broad street terminal is of the stub-end type. There are 16 tracks in the train shed, but at the interlocking tower controlling the entrance to this terminal, there are only six tracks.

In 1915 this terminal had reached the limit of its capacity of 160 trains per day with steam operation. The physical conditions were such that it was almost impossible to enlarge this terminal, and to increase its capacity electric operation of much of the suburban service with multiple unit cars was inaugurated. All cars are equipped with two alternating current motors on one truck and trains are made up of from three to eight cars. The time required to bring a motor car train into the station and get it out again—including unloading and loading—is approximately one-third of the time required with steam operation. The track movements per train turn-around have been reduced from six to two.

Through the six-track bottle neck at the interlocking tower, approximately 600 trains per day are now operated. Between 5:00 p.m. and 6:00 p.m. 50 trains pass this tower and during one 17-minute period of this hour there is a train movement every minute. This terminal had a capacity of only 160 trains per day with steam motive power.

With electric operation the running time from Broad street to Paoli—20 miles—has been reduced 10 minutes. With steam operation 82 per cent of the suburban trains were on time while with electric operation the corresponding figure is 94 per cent. During the year 1919 a total of over 2,883,000 car miles were operated with an average of over 48,000 car miles per detention. During one month of this year a total of 252,200 car miles were operated with five detentions, totaling 14 minutes.

Chicago, Milwaukee & St. Paul

The Chicago, Milwaukee & St. Paul electrification is the only example of an extensive single track electrification of a transcontinental railroad. The original installation covered 440 miles from Harlowton, Montana, to Avery, Idaho. On this section the Big Belt, Rocky and Bitter Root mountain ranges are crossed. With steam operation there were four engine districts on this section. The second installation extends from Othello to Seattle, Washington—a distance of 220 miles—and this section crosses the Cascade mountains. Passenger service is handled by the most powerful passenger locomotives in the world, and these locomotives are making mileage far in excess of any previous records. They have ample capacity to haul a 13-car all-steel train over the entire electrified zone without helper.

Soon after these locomotives were placed in service it was decided to run them through the entire 440 miles without turning in at Deer Lodge shops—near the middle of the electrification zone—for a general inspection as had been the previous practice. This was a radical step but the results obtained have certainly justified this plan of operation. The locomotives are given a light inspection at the end of the 440-mile run and are sent to the main

shops at Deer Lodge for a general inspection on a mileage basis of from 3,000 to 5,000. Two men at each terminus of electrification—Avery and Harlowton—take care of the light inspection.

Individual locomotives in this service have made as much as 12,000 miles in one month. They have made the through run of 440 miles per day for 12 consecutive days during the most severe winter months. On the occasion of schedule derangement on the steam-operated sections of the road, these electric locomotives have been kept in continuous road service as much as 30 hours and have made over 750 miles in a 24-hour period.

The substitution of electric for steam motive power on the Chicago, Milwaukee & St. Paul has made it feasible to greatly simplify the operating organization. The 440-mile section is now in charge of one superintendent with two sets of train dispatchers, whereas with steam operation there were two division superintendents and four sets of dispatchers. Eliminating intermediate engine terminals has, of course, simplified the mechanical department organization also.

There are many other noteworthy railroad electrifications. Those mentioned, however, represent all classes of heavy traction service which electrification will be called upon to perform.

Road Test of Clifford Automatic Train Control

A DEMONSTRATION and test of an automatic train control device which has been developed by the Clifford Automatic Train Control and Signal Corporation was made on the Erie before the New York Central Lines Signal Committee, Train Control branch, other interested railroad men and guests on November 28. A Pacific type passenger locomotive was equipped with the control apparatus while other apparatus was used in the car to demonstrate its operation. The tests were made on the eastbound main track between Port Jervis, N. Y., and Graham, four block sections being equipped with the train control circuits.

The train control apparatus developed by this company is what is known as the "conductive" system. It gives an indication at any point in the block corresponding to any change which takes place in the track conditions ahead. No roadside apparatus is employed, as a superimposed circuit is used in connection with the track circuit and the drop in voltage between the front axle of the engine and the rear axle of the tender in train control territory is utilized as the primary impulse to actuate the apparatus. Through the primary impulse, which actuates specially designed three-position polarized relays, other relays, of the telephone type, are controlled; which in turn govern a solenoid magnet which actuates the air apparatus and also the cab signal. The cab signal is auxiliary to the system itself and can be used or not as desired. This signal consists of white, red, yellow and green lights, from which four indications are obtained. Time element relays of the inverse time element overload type are used in connection with the delayed application effect. The entire electrical equipment, with the exception of the eight-volt storage battery, will be contained in a box 5 in. by 8 in. by 12 in. mounted in a convenient location on the engine.

The circuits used in the test were d. c. polarized circuits of the double rail type. The imposed circuits are carried to the rails over two No. 6 B. & S. gage copper wires and equalized by keeping the voltage in the two rails balanced with the line. The imposed voltage is approximately 18 volts per circuit. In order to get the advance indication the polarity is reversed on the imposed circuit. Current is required in each block section to permit the train to proceed, and in this manner the apparatus is made self-checking. The circuits which can be used are the double rail imposed circuit, the single rail imposed circuit or the diagonal wired double rail imposed circuit. These have been designed to meet varying conditions and their application is not confined to d. c. steam road operation. An eight-volt storage battery is used to operate the air valve and cab signal lights on the locomotive.

The engine air equipment consists of an eliminating valve cut in the main reservoir lead between the engineman's automatic brake valve and the pipe leading to the main reservoir. The function of this valve is to prevent the engineman from releasing his brakes after an application is made, but it does not prevent him making a greater application if desirable. In addition to the eliminating valve there is an electro-pneumatic or solenoid valve controlled through the track circuit; and also the actuating valve, which sets in motion the automatic brake control valve, which in turn controls the eliminating valve which makes the proper brake pipe reduction. After the proper brake pipe reduction has been made, the actuating valve returns automatically to its normal position. After the stop is made, there is a releasing valve which, when opened, actuates a piston in the eliminating valve which again opens up the lead from the main reservoir to the engineman's automatic brake valve.

Under normal conditions the solenoid valve is always energized. When it is de-energized the solenoid opens an air valve which allows equalizing air to flow against a piston in a graduated air valve which produces an application of the brakes in proportion to the speed of the train and at the same time cuts off the main reservoir supply to the standard E. T. or L. T. brake equipment so that the engineman cannot release his brakes until the train is brought to a stop; but he can make a heavier application if he wishes. As stated above, after the solenoid valve produces the necessary stop application it closes automatically and returns to normal, leaving the standard brake equipment lapped and the automatic features of the train control device ready for a further application.

The tests made consisted of running the engine in automatic block signal territory not wired up with the train control circuits to show that the engine equipment was not sensitive to the ordinary track circuit; engine running in train control territory with the blocks clear; a shunt put on the track two blocks in advance, showing that the engine would receive an advance caution indication (white and green light) two blocks back, and a caution (yellow light) followed by a stop indication (red light) with an automatic brake application in the next block; a test of the air apparatus to show that the engineman could not prevent the stop but could make a greater application of the air, and a test showing how the device operated when attempting to follow a train too closely.

When the engine entered train control territory, not occupied, the green light showed. A shunt was then put

on the track two blocks ahead and the white and green lights showed, these automatic functions taking place irrespective of the train's position in the block. When the train ran into a red block at a speed of 45 m. p. h. or under, the yellow light showed up for about 20 seconds (delayed application), after which the yellow light went out, the red light came on and the train was stopped automatically. If the train operates at a speed over 45 m. p. h. there is no delayed application, but the red light appears immediately and the stop takes place.

The next test was made with the train moving at approximately 25 m. p. h. by putting a shunt on in the block in which the train was running. A delayed stop application was made. With the shunt still on, the engineman released himself after coming to a full stop and then proceeded. The shunt was then taken off with the train in the block and the apparatus cleared up automatically, the green light showing.

The train next went on a siding to allow another train to pass, and after it had cleared the block the train backed out of the siding, the apparatus automatically indicating a clear block by the green light showing.

The next test consisted in opening the track wiring on one of the superimposed circuits to show that the apparatus would still function through the remaining circuit on the one rail. When the train ran from automatic train control territory into non-automatic train control territory an automatic stop was made with the apparatus as it was installed for test purposes. After the engineman released himself he could then proceed without receiving additional stops.

In order to test the effect of foreign current keeping a track relay energized with a train in the circuit, a shunt was put on a block in advance of the train and the track relay was maintained in its normal position corresponding to no train in the block. When the train ran into this section it was automatically stopped in braking distance. This test produced the same effect as if the train had run from automatic train control territory into non-automatic train control territory.

Another test made was to have the test train attempt to close up the gap between itself and a train ahead. In this test the proper indications were received, corresponding to the positions of the trains in the respective blocks, but when the test train ran into the block ocupied by the train ahead, the test train was automatically stopped.

As the speed control apparatus was not installed no speed control tests were made, those conducted being in connection with the automatic stop feature only.

Small Vertical-Type Air Compressors

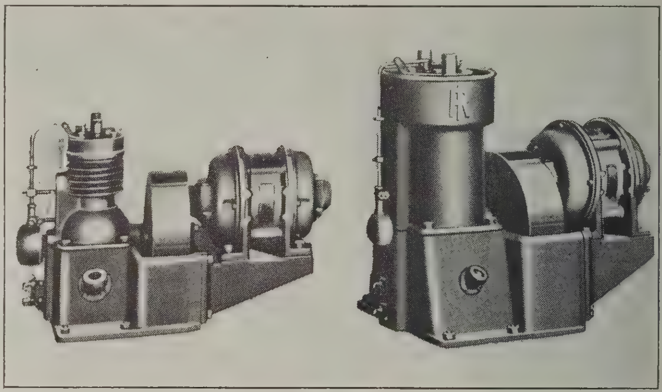
The Ingersoll-Rand Company, New York, announces a new line of small vertical air compressors known as Type Fifteen. In addition to plain belt drive, each of the four sizes is built as a self-contained electric motor outfit, driven through a pinion and internal gears, or by employing a short belt drive arrangement. The compressing end and electric motor of both gear and short belt-drive units are furnished mounted on a common subbase, so that they are in no way dependent upon the foundation for correct alinement.

Several noteworthy features of construction have been incorporated, of which the constant-level lubrication system is the most important. Others include the constant speed unloader for plain belt-drive machines; the centrifugal unloader for start and stop control machines; and the increased size of the water reservoir cooling pot.

The lubrication of small vertical compressors employing the enclosed crank case and splash system has often been a source of concern wherever oil in the air is a serious menace. The tendency of the old system has been to feed too much, resulting in the discharged air containing excess oil, or too little, causing scored cylinders, excess loads and burned out bearings.

As with the ordinary splash system, the base of the compressor forms an oil reservoir for the constant-level system. However, with this system, pet cocks determine the maximum and minimum amount of oil in the reservoir. Above this reservoir and directly underneath the connecting rod in a constant-level pan. Oil is pumped from the reservoir into this constant-level pan through a unique oil pump. Regardless of the amount of oil in the reservoir, so long as it is somewhere between the high and low level pet cocks, this system will function, insuring a constant-level of oil in the pan. A projecting stem on the connecting rod dips into this pan and distributes just a sufficient quantity of oil for proper lubrication of the bearings.

The constant speed unloader controls the unloading of the compressor by automatically opening the inlet valve



3-in. by 3-in. Air-Cooled and 4½-in. by 5-in. Water-Cooled Ingersoll-Rand Air Compressors

when the receiver pressure rises above that at which the unloader is set to operate. When the receiver pressure has fallen a predetermined amount, the unloader automatically releases the inlet valve and allows the compressor to return to work and thus build up the receiver pressure again.

The centrifugal unloader allows the compressor to start under "no load" such as is essential when automatic start and stop control is used, and permits the electric driving motor to come up to full speed before the load is thrown on automatically. This unloader accomplishes its purpose by holding the inlet valve open until the motor has reached full speed.

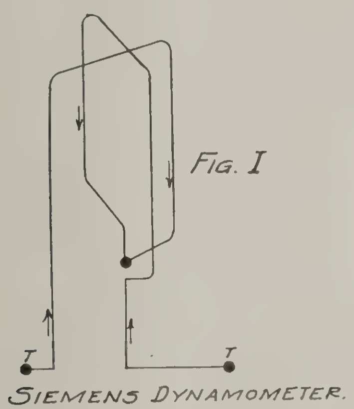
The smallest size is built with either ribbed cylinder for air cooling, where the service is intermittent, or a water-jacketed cylinder of the reservoir type for constant service. All other sizes are built with the water jacket of the reservoir type. The belt and electrically-driven machines include the 3 in. by 3 in. air-cooled, the 3 in. by 3 in., the 3½ in. by 4 in. and the 4½ in. by 5 in. water reservoir cooled machines.

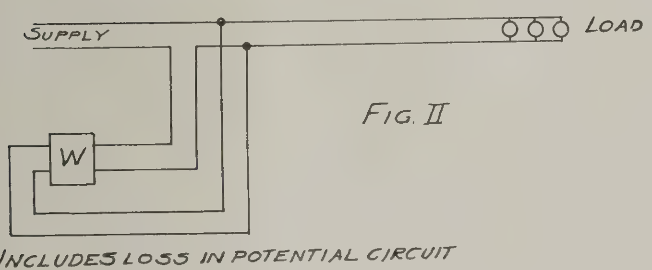
Electrical Instruments in Common Use

A Practical Explanation of the Construction and Connections of Meters Used in Testing

An ammeter is essentially a galvanometer or electro-dynamometer of rugged construction provided with a needle moving over a scale which is calibrated to read directly in amperes. The moving element is usually supported in jewelled bearings. Ammeters commonly used are of the following types: Moving-magnet, soft-iron vane, Thomson inclined coil, hot-wire induction, moving coil, and electro-dynamometer type.

The dynamometer type is used in precision alternating current instruments, utilizing the effect of one conductor carrying a current moving under the influence of a stationary coil carrying the same current and connected in series to the moving coil. The restoring force in these instruments is sometimes gravity, but is generally due to the springs that carry the current in and out of the moving coils. Fig. 1 shows the simplest form of electro-dynamometer as devised by Siemens.





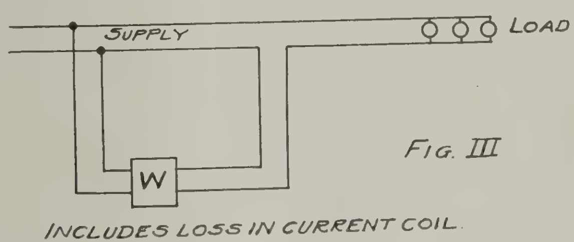


Fig. 1—Principle of Dynamometer
Fig. 2—Wattmeter Connection Including Potential Coil
Fig. 3—Wattmeter Connection Including Current Coil

Direct current ammeters are usually of the moving coil type, in which type a permanent magnet maintains a field in a fixed location, and the current to be measured is passed through a moving coil, entering or leaving by springs that furnish the restoring force.

An ammeter must always be connected in *series* with the circuit to be measured, as the internal resistance is very low. Portable ammeters should be used in a horizontal position unless otherwise specified. All contact surfaces should be kept clean.

For using ammeters with more than one scale the highest scale should be connected in first so that the possibility of burning out the winding is partially eliminated. Alternating current ammeters usually run to one scale only, whereas direct current ammeters are generally designed with up to 3 scales. To get the proper overlapping of scales requires the use of ammeters with scales from 0.050 amp. up to 100.0 amp. The low reading scale is used to check the consumption of energy in low wattage lamps and the higher range of 100 amp. to measure the current output at the transformer.

When selecting a.c. ammeters it must be remembered that 20 per cent of the left-hand side of the scale is negligible. In other words, only about 80 per cent of the scale can be used, due to the fact that the torque of the instrument is proportional to the square of the current passing through the windings. Generally speaking, alternating current ammeters are designed for almost any frequency from 25 to 130 cycles.

Voltmeters A. C. and D. C.

A voltmeter is an instrument used for measuring the potential difference or voltage between terminals. Usually the internal resistances of voltmeters is considerably higher than that of ammeters, running anywhere from 4 to 25 ohms per volt.

The high resistance within an a.c. voltmeter is wound non-inductively, *i. e.,* the wire is doubled back on itself before being wound on the spool. This system of winding reduces the self-induction of the coil so that the total impedance of the meter is then practically equal to its total resistance and consequently its indications are only slightly affected by the frequency of the voltage. Voltmeters can be used with a multiplier in series with the instrument to give voltages up to 750 volts. These multipliers or resistors are made of high resistance alloys having a low temperature coefficient and wound non-inductively.

In using all types of measuring instruments, proper leads should be used, that is, where heavy currents are to be measured, leads should be of large enough cross-section to overcome an abnormal drop in voltage. Leads should be provided with terminals to fit under the binding posts of the instruments. Otherwise with leads made of flexible wire the ends will fray out and some of the small conductors will become grounded or short-circuited to the adjacent binding post or instrument frame.

Wattmeters

A wattmeter is a device for measuring electric power and is particularly useful for measuring alternating current power. Wattmeters are usually designed on the

electro-dynamometer principle, in which the current in the circuit or known part of it is sent through the current winding; and a small current in phase with the e.m.f. across the terminals of the circuit is sent through the potential coil. (See Figs. 2 and 3.) The moving coil is ordinarily used for the potential coil. Multipliers or resistors can be employed in testing up to 25,000 volts.

In a wattmeter designed on the electro-dynamometer principle the current in the current coil is practically proportional to the load current at each instant and the current in the potential coil is practically proportional to the voltage across the load at that instant. Therefore the instantaneous torque acting on the moving element at this instant is proportional to the instantaneous power. The average torque acting on the moving element during each cycle of the current and voltage is then proportional to the average power.

Portable wattmeters are usually of a low power factor, which makes it possible to measure watts with a good scale. They are ordinarily made in sizes up to 200 amp. and 750 volts. Portable instruments for large currents and voltages are not generally used, because higher ranges can be taken care of by instrument transformers.

A wattmeter may be connected to the load to be measured as shown by Figs. 2 and 3. Figure 2 includes the loss in the potential coil and Fig. 3 includes the loss in the current coil, so that for accurate work a correction should be made unless the instrument has been compensated.

The wattmeter is a very useful instrument in measuring the power taken by a motor or electrical device. In direct current the power is equal to the volts multiplied by the amperes, whereas in alternating current this is not true, unless the voltage and current are exactly in phase, which seldom happens, due to iron in the circuit, such as cores of transformers, etc. In this case the power factor of the circuit must be known. However, a wattmeter will measure the power automatically in an alternating current circuit, due to the fact that it measures *average* values. Wattmeters have been designed to measure power on single and three-phase circuits.

Wattmeters, voltmeters and ammeters should be tested from time to time by comparing them with standard instruments. The mechanism of these instruments should not be tampered with unless by some competent person. Experience has shown that where more than one instrument is on hand it is well to have one instrument left in the laboratory or shop that compares very favorably with standard instruments in standard laboratories. This instrument should be considered a standard by which field instruments are to be compared at least twice a year.

Phase Angle Meter

A phase angle meter is an instrument used to measure the angular difference in the currents or voltage in two circuits. This instrument is designed on the lines of a wattmeter using the electro-dynamometer principle, in which one coil is used as a current coil and one as a potential coil. The instrument is portable and resembles to a great extent a portable wattmeter and can be designed for any commercial frequency and for almost any local or potential coil voltage, say 12—55—110 or 220 volts.

The Megger

The megger (ohmeter) is an instrument of the galvanometer type and is generally used to measure insulation resistances where high accuracy is not desired. The scale is graduated to read directly in megohms (1,000,000 ohms), from whence its name is derived.

The megger is designed for portable use. The instrument is provided with two binding posts, one marked line and the other marked ground. When an insulation is to be tested, both ends of the wire are disconnected. One end is connected to the terminal marked line and the other end left free. The handle of the instrument is then turned for a few seconds and the reading on the dial will show the resistance of the dielectric to ground.

This instrument is sometimes used with a resistance box so that Varley and Murray loop tests can be made to locate crosses and grounds. In this case it is essentially a Wheatstone bridge.

The megger consists of a d.c. generator (usually generating about 500 volts at 0.003 amp.), a special galvanometer, consisting of a permanent magnet, a soft iron core, a current coil and two pressure coils. The three coils are attached to a shaft which carries the needle at a fixed angular distance. The generator and galvanometer are located in a box at one end of the instrument provided with the two binding posts marked ground and line, to which the unknown resistance is connected.

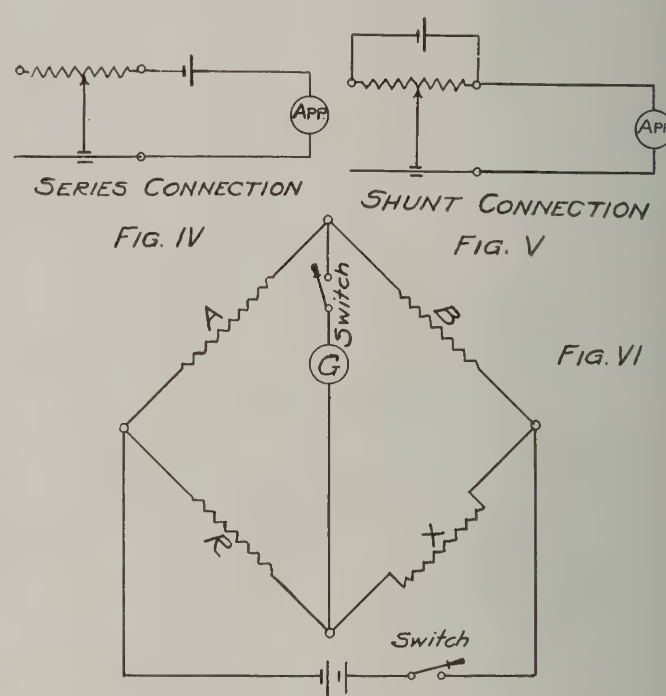


Fig. 4—Series Connection of Resistor
Fig. 5—Shunt Connection of Resistor
Fig. 6—Connections for Wheatstone Bridge Test

The pressure coils are permanently connected across the terminals of the generator. The current coil is made to move through an annular gap in such a manner that the field in which it moves is uniform, whereas the pressure coils move from a midway position between the poles where the field is at a minimum into a stronger field. The connections are such that a torque due to the current in the current coils is opposed by the torque due to the current in the pressure coil. When the current through the current coil is increased by connecting up to the lower resistances, the current coil drags the moving element around in a clockwise direction; since the pressure coils come into a stronger field, the resistance to this move-

ment becomes greater and greater. Therefore, a definite position is assumed by the system for the unknown resistance. In addition to being used to test wire insulation, a megger can be used to test the insulation of transformers, terminal boards, etc.

The megger is provided with a clutch in connection with the hand generator so arranged that when a certain speed is reached the clutch will slip beyond this speed, resulting in a constant voltage being generated. For laboratory use meggers can be connected to a motor running at the proper speed. Meggers can be obtained with a capacity up to 1,000 megohms for use in testing the insulation on large power and third-rail cables where the cross-section of the cables runs up to 6,000,000 C. M. The accuracy of meggers is about 4 per cent.

Resistors

A resistor, or rheostat, is a device commonly known as a resistance, used for the operation, protection or control of a circuit or circuits. The cross-section of the wire used in making the resistor depends upon the amount of current to be controlled.

In a.c. work the wire is usually wound on a non-magnetic tube such as a slate rod, or it may be wound non-magnetically, in which case the wires are laid back upon one another. When large currents are to be regulated, and continuous control is desired, carbon blocks are used in which case up to 4,000 watts can be controlled with a large margin for overloads. These carbon blocks are practically indestructible. Resistors can be connected in series or in shunt as shown by Figs. 4 and 5.

Usually where currents greater than 5.0 amp. are to be controlled, resistors are wound with resistance strips instead of wire. The wire or metal strips wound about the tubes or rods are coated with a thin film of oxide to insulate the adjacent turns wound without space between them. This construction overcomes the small difference of potential between the adjacent turns, thus, increasing the capacity of the resistor for a given dimension.

If the resistor is of the tubular design, an excellent ventilation is secured with ability to radiate a large amount of heat. If the resistor is to be connected as a shunt, particular care must be taken to see that the line voltage will not send more current than the rated current (capacity is usually stamped on the sliding contactor) through the resistance of the winding alone, and that the total current flowing in the unshunted portion of the resistor (sum of currents in the shunted portion and the apparatus under test) is not in excess of the rating.

To get the proper capacity with the proper resistance to control the circuit it is necessary sometimes to connect two or more resistors in series. In this case one or two slides can be used. In this manner the resistance can also, if necessary, be connected in multiple by the use of proper connections. Some resistors are equipped with a switch so that by opening or closing the switch either series or shunt connections can be made.

Wheatstone Bridge

Bridges are usually of the portable type, in which case the battery, galvanometer, switches and resistance coils are mounted in the same box. There are several types of bridges, all of which are designed along practically the same lines.

A Wheatstone bridge consists of two sets of coils usually called ratio arms whose *relative* resistances must be known but whose actual resistance values are not necessary. The resistances both known and unknown are usually connected in a diamond in which case R is a standard variable resistance; X is the unknown resistance; G is sensitive galvanometer connected across two points of the diamond, and B is a battery connected across the other two points of the diamond combination. See Fig. 6 for the connections.

Following are some of the rules to be observed in using a Wheatstone bridge:

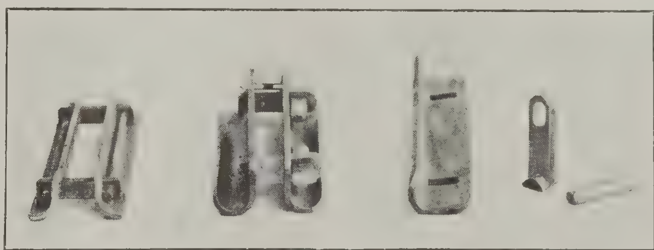
1. Do not use a battery having an e.m.f. of over 5 volts.
2. Always shunt the galvanometer during preliminary adjustments. The shunt circuit should be opened when the final balance is made.
3. See that all binding posts are tight.
4. In manipulating the keys be careful not to touch metal parts, as this may appreciably affect the readings.
5. Always close the battery switch first and then the galvanometer switch.
6. If the leads to the resistance under test are long, the resistance of the leads should be measured and then deducted from the final reading.

Bridges are used where accuracy is required, such as measuring the contact resistance of relays, low resistance coils, and for locating crosses or faults in underground and aerial cables if a megger or resistance box is not at hand.

Improved Belt Fastener for Axle-Driven Generators

An improved car lighting belt fastener of the Walker type is being manufactured by the Safety Car Heating and Lighting Company, New Haven, Conn. One of the old type of fasteners is shown at the left of the illustration and one of the improved fasteners next to it.

The fastener is made of steel as previously, but is somewhat heavier and the two lower edges are curved upward and away from the belt to prevent cutting of the belt at this point A link and a wedge used with the new fastener are shown at the right. Two of these links and two wedges have been substituted for the two straight links and straight pins used with the older type. The oval shaped hole in the new link permits the use of belts of different thicknesses. After the belt has been punched and the two links pushed through the belt and the slots in the two halves of the fastener, the wedges are driven into the oval holes with a hammer. With the old type of fastener, every different thickness of belt required a different length of link to get proper results; with this new type only two lengths are used, one for four and one for five ply belting. The design has the additional advantage of increasing the amount of pinching action of the upper edges of the fastener on the ends of the belt.



Old and New Types of Fasteners and Parts of the New Type

A Noisy Power House Telephone

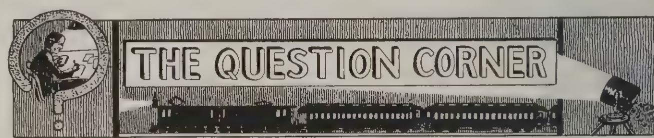
About two months ago they put a telephone in the power house, but nobody could use the thing for the noise and hum. It was in one of these double-walled booths, soundproof they call them, but it didn't seem to make any difference whether the door was open or closed. The electrician who put it in looked it all over and checked-up all the wiring, even transferred the lead-in wires to another part of the building but that didn't seem to do any good. I asked him what the trouble was and he said "Inductive Interference." Now that didn't mean anything to me so I just nodded my head and said, "Yes, I suppose it is."

After a lot of trying for several days without any results the electrician left the outfit and the engineer continued to yell and perspire there in the booth trying to make himself heard. Then in about a week the electrician was back again with a kind of a can with a pointed end marked "Drainage Transformer." He put that up on the wall above the booth and connected the telephone wires to it, but that was as far as he got; the telephone was just as noisy as ever. The next day his boss dropped off of No. 6 and came over to the power house. He is a radio fan and when he tried the telephone he just smiled and said he would send the necessary stuff to the electrician right away. In a few days the electrician had four little jimcracks without any label on them which he hung in a sort of festoon over the top of the telephone in the booth. After those things were put in there, the noise seemed to stay about the same but the sounds you wanted to hear were fainter.

Nothing that they did seemed to make the slightest improvement and by that time the engineer, he's my boss, was getting awful sore. Now if there is anything I don't like, it is working for a man with a grouch, so I did my best to do a little thinking. Last Thursday I was over in the storehouse and I saw some soft rubber discs about an inch thick. I didn't want to let anyone know what I was going to do with it so I borrowed one and took it over to the power house. While the engineer was working down in the pump pit, I cut the rubber disc into four pieces, pried up the telephone booth with a pinch bar and put one piece under each corner. The noise in the telephone stopped almost altogether; it seems that it all was caused by vibration from the machines that carried through the concrete floor.

I don't know what the moral of this story is, but it seems to me there must be one. Maybe you think I'm not solid with the boss. HELPER.

Don't waste time trying to impress people with the importance of your own importance.



Answers to Questions

1. If the current in a circuit in which the resistance is constant depends upon the pressure, why is it that the current is the same in all parts of a series circuit when there is a voltage drop all along the line?—R. A.

2. If the voltage of a battery on open circuit is 2 volts and charging current is sent into it, would the potential rise at the battery terminals equal the drop due to internal resistance of the battery?—A. O.

1. The resistance of the line forms a part of the total resistance of the circuit, and this resistance from one pole of the generator through the circuit and back to the other pole is what limits the current for a given voltage. Any increase of resistance in any part of the circuit, either in the line or in the apparatus, would result in a corresponding decrease in current strength, assuming the voltage at the generator terminals remained constant. Whatever current is sent out from the positive pole of the generator must necessarily go through all the apparatus in the series circuit and return to the other pole of the generator.

2. The voltage of a storage battery rises quickly when it is placed on charge. This is partly due to the increase in the internal ohmic resistance of the battery and partly due to a polarization effect which is somewhat similar to that experienced with a dry cell on discharge. In both cases the flow of current is opposed. The ohmic resistance of the electrolyte is decreased slightly because of the fact that the acid in the plates is driven out of the active material into the electrolyte. This leaves a filament of active material on the surface, however, which is almost free from acid, and there is accordingly a higher resistance at this point. This, however, is not nearly as important a factor in the rise in voltage as is the chemical change within the battery produced by the flow of charging current. This latter causes the counter electromotive force of the battery to increase very rapidly at the start and to continue to rise until near the end of the charge, when gasing begins. The bubbles of gas greatly diminish the contact surface of the electrolyte with the plates and so increase the contact resistance with the

active material at this point. This causes the abrupt rise in the voltage at the end of the charge, which is always experienced when gasing begins.

* * *

Following is a discussion upon one of the questions which appeared in the Question Corner for September, but which space did not permit of publication last month.

* * *

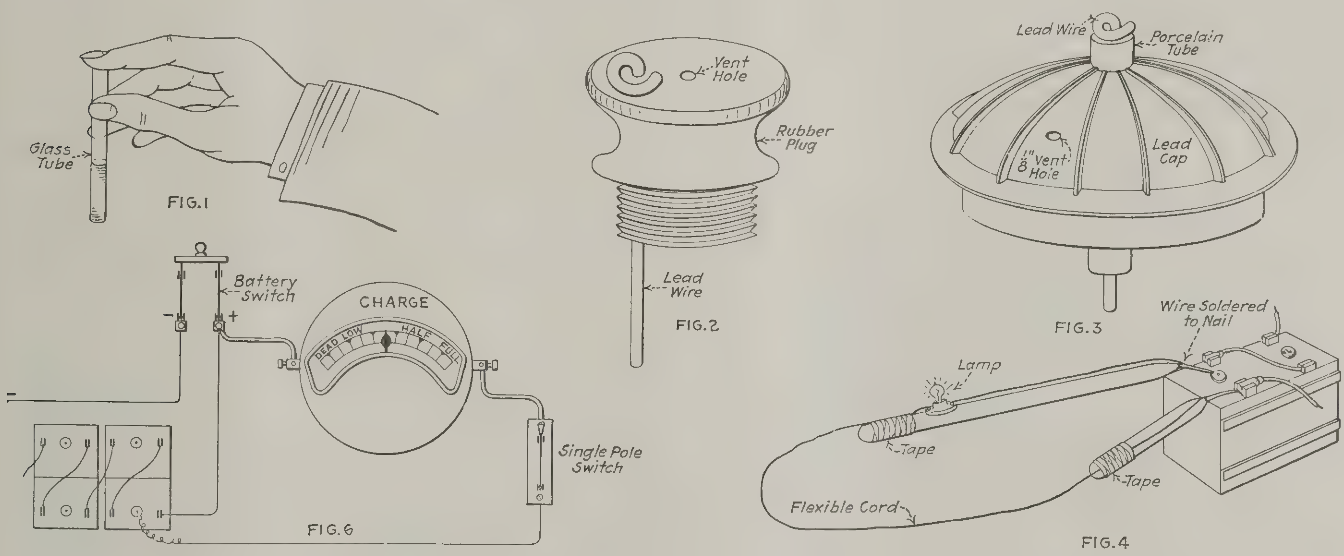
Ascertaining the height of the electrolyte in storage cells in some cases is a fairly simple matter, and can be accomplished by using a piece of glass tube as shown in Fig. 1. If there is plenty of space in the battery box one might possibly take the level of acid in the rear cells, of the double unit type, but that's a question. Generally there is not enough room for a sand fly to walk upright. Of course, in a good battery the level in one cell is the same as the rest, but even then some one might flush the front cells and forget the rear ones. Some cells are equipped with floats which is a good idea, hence the following stunt.

The material needed is a few feet of lead wire or rod, about 3½ in. per cell, the length depending on distance between plates and cell cover, a 2.5 or 3-volt lamp and miniature base socket is also needed, and 5 ft. No. 16 or 18 flexible cord. In the case of the U. S. L. type of cell, with wood or hard rubber corks, drill a hole at the side of vent hole large enough to take the lead wire or rod. Cut off a piece of lead wire long enough to reach within ½ in. of the plates and to bend over on top of cork to prevent its falling into the cell. See Fig. 2. The Willard cell with the large filling and vent cap made of lead requires a short porcelain or hard rubber tube. In this case the vent hole in the center is enlarged to take the tube and the lead wire passed through this tube as shown in Fig. 3. Drill an additional ⅛ in. hole for the vent. This method applies to all cells equipped with lead stoppers or vent caps.

The tester consists of a wood rod about 24 in. long into one end of which is driven a large nail with head cut off and filed to a point. Another rod, 12 in. long, is also required and a nail driven in one end of the same as with the longer rod. On the other end of the long rod the miniature base socket is fixed, and the whole connected as shown in Fig. 4, which also shows how the tester is used. If the electrolyte is high enough, that is, at least ½ in. over plates, the lamp will light up. In this way it is possible to go over all the cells in the set in a very short time and without pulling the cells partly out of battery box. By using a voltmeter in place of the lamp, the reading will give a practically positive indication of the condition of battery charge. Following is a list of readings of a standard U. S. L. battery.

Specific Gravity	Voltage	Condition of Light
1100	.1	Dead
1150	.2	"
1165	.3	"
1175	.8	Dim
1190	1.5	Dull
1200	1.7	Fair
1215	1.9	O. K.
1225	2.	Bright
1250	2.1	"

This shows how the specific gravity varies with the voltage, a complete list of the specific gravity could be thus made and the testing set used instead of the hydrometer—the readings are taken on open circuit—that is to say, the lights are not turned on, as is usual with the voltage readings. I would suggest placing a voltmeter in the car locker connected to one of the cells, and its dial, instead of reading in volts, be marked—dead—low—half and full charge as shown in Fig. 6, so that the condition of charge could be seen at a glance.—A. W. M.



A Number of Devices for Measuring the Height of Electrolyte in Storage Batteries

* * *

Question for December

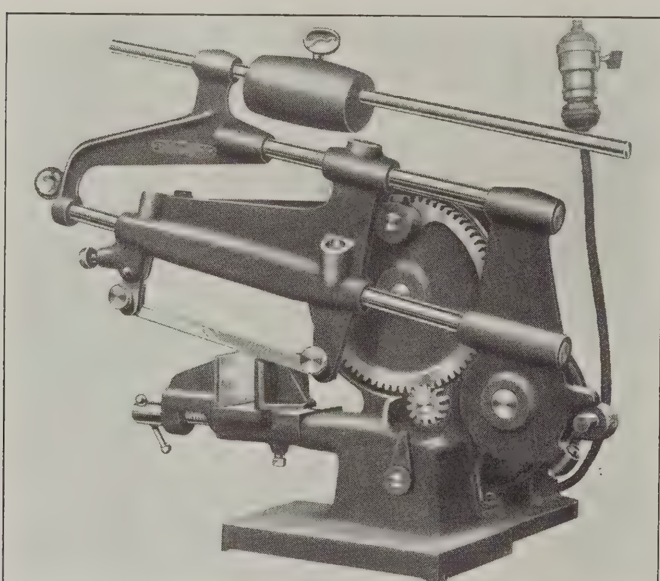
1. Is it possible to operate a 6-volt radio set from d. c. 110-volt line by reducing the voltage with lamps in series, or by using a resistance?

2. Would you be able to let me have the address of the concerns manufacturing the following systems of car lighting and locomotive lighting equipments: Buttner System; Brown, Boveri System; Consolidated Systems Type A and Type D and L System Regulators; Dick System; G. E. L. System; Gould Simplex System; Leitner System; Mather and Platt System; Newbold System; Pintsch-Grob System; Safety System; Stone System; U. S. L. System.

NEW DEVICES

Motor-Driven Portable Bench Hack Saw

Laborious and careful hand work is no longer popular nor desirable in the railroad shop. It is a serious question whether the modern railroad shop man has as much patience and steadiness in using a hack saw or file as was common in former years. Fortunately, individual motor drive can now be applied practically and economically to small machines. For example, the small motor-driven bench hack saw illustrated can be set up



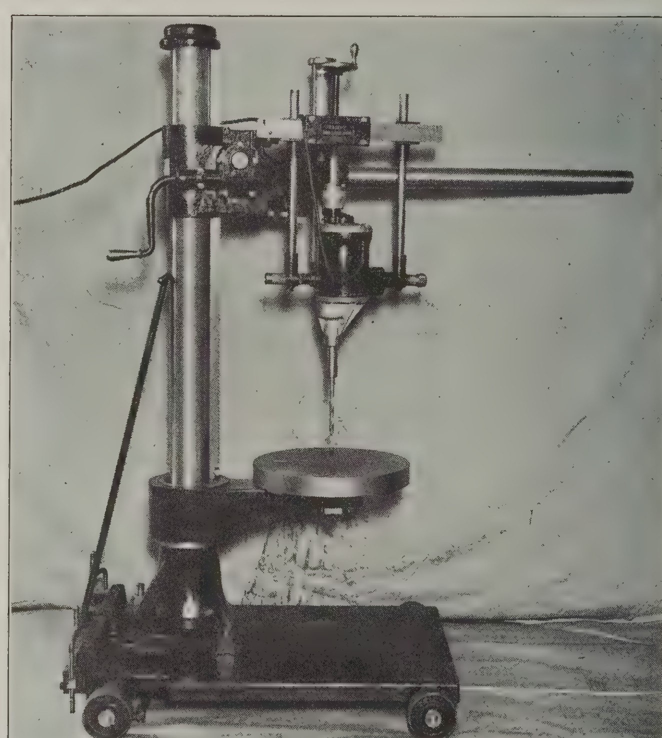
Edlund Portable Power Hack Saw

wherever convenient on the bench adjacent to an electric light cord and it will saw off any piece of iron within its capacity far more quickly, smoothly and with less damage to the saw blade than could be done by hand. Time is saved; physical effort is saved; saw blades last longer; and workmen can do something else while the machine is working. Another advantage is that this small hack saw can handle a large share of the work usually done on much heavier machines. It is designed for long life and ease of operation and all parts subject to wear are easily replaced. Both tool and machine steel can be cut efficiently and the machine is well adapted for use in toolrooms and machine shops, particularly those having considerable hack saw work formerly done by hand.

Power is supplied by a small motor direct-connected, the power being transmitted through cut gears. The machine is portable and can be attached to any electric light socket. It will be observed that cutting is done on the backward stroke, the saw blade being automatically relieved on the forward stroke which diminishes the wear and greatly prolongs the life of the blade. This portable bench hack saw is made by the Edlund Machinery Company, Inc., Cortland, N. Y.

Portable Electric Radial Drill

Another example of portable tools made possible by individual motor drive is shown in a portable radial drilling machine, known as the Lindhe portable radial which has been placed on the market recently by Manning, Maxwell & Moore, Inc., New York. This machine equipped



Lindhe Portable Radial Equipped with Removable Electric Drill

with an electric portable drill of suitable capacity is shown in the illustration. The tool is substantial in construction, consisting of a portable drill in a universal head, mounted on a radial arm capable of vertical adjustment on the column. The column swivels on a base rigidly attached to the truck which permits easy movement on the floor to various places where work is to be performed. The base is supplied with sliding bars, adjustable where the floor is not level; also offering a lock for the truck while the drill is in operation. The radial arm is movable on its brackets and can be swung in a full circle providing positions desired at any height or angle within its reach. An eyebolt in the top of the column affords means for lifting the machine with a crane.

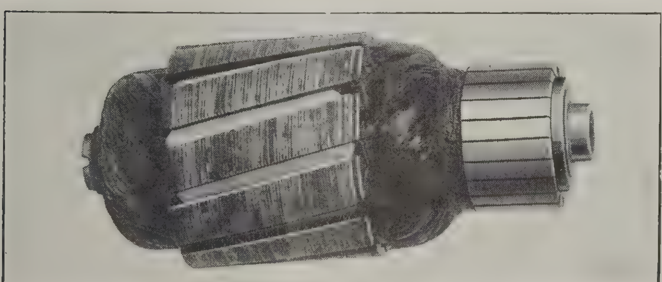
The universal head, mounted on the radial arm and carrying the drill, will slide about and rotate around with the radial arm which furnishes additional movements for positions desired while drilling. The universal drill head has a feed screw for hand pressure while the drill is in operation, thus permitting full control. All of the above mentioned movable parts are provided with strong locking devices for securing them in position. All gearing is enclosed and dust proof, being self-lubricating. The cross bar section on the universal head is provided with chains to furnish support should the work be heavy or if work is in an extremely remote position to the machine. The machine can be furnished with any make of electrical or pneumatic portable drill or with fittings so that the customer may attach his own drill.

The base of the machine is 30 in. by 43 in., the extreme height of the drill above the floor being 5 ft. The radial arm is 4 ft. 6 in. long measured from the center of the column. The drill table is 18 in. in diameter which is also the distance from the center of the column to the center of the table. The diameters of the column, radial arm and wheels are 4½ in., 3 in., and 5 in. respectively.

Electric Fans With Interchangeable Motors

A complete line of electric fans is now being offered by the Safety Car Heating and Lighting Company, New Haven, Conn. These comprise a ceiling fan with revolving air deflector, removable and stationary bracket fans and exhaust fans—both vertical and horizontal.

One of the advantages claimed for these fans are their interchangeable motors. The armature can be used interchangeably on four different types of motors for six different fans. A different shaft is used for each of three types of motors.



Interchangeable Armature for Fan Motors

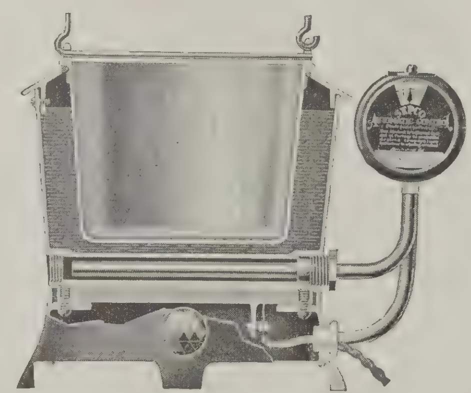
The punchings which form the armature core are riveted to a sleeve at each end of the armature. Three rivets, which extend through the stack of punchings, hold both sleeves. The winding slots are skewed for the purpose of making the motor run quietly. The armature is wound with silk-covered enameled wire and is dipped and baked after winding. The coil leads are soldered to the bars of a mica insulated commutator. Fibre wedges are used to hold the windings in place. The commutator is secured with a force fit to the sleeve.

All of the motors, vertical and horizontal, with which this armature is used are series wound ball-bearing motors. Plain sleeve bearings can be used to replace the ball bearings in the horizontal motors. No extra parts are needed for the change. The motor frames are made from steel tubing, while the heads are interchangeable die castings. The brush box is a die casting and the brushes are square in section. Constant and uniform pressure is applied by the brushes on the commutator by means of flat spiral springs. The motors are totally enclosed, but there is an easily removable cover on the commutator end.

These fans can be supplied for 30, 60 or 110 volt service and arranged for one, two or three speed operation.

Glue Pot With Automatic Heat Control

Glue attains its greatest flexibility and viscosity at about 140 to 150 deg. F. At a temperature of 176 deg. F. glue loses its tensile strength. Similarly, if it is cooled to 104 deg. or less, there would be a decided fluctuation in the strength or holding quality. Obviously, some kind of heat control in glue pots is desirable and this is obtained in the one illustrated, made by J. D. Wallace & Co., Chicago.



Wallace Electric Glue Pot. Temperature is Held Automatically at Any Desired Value

This glue pot is provided with a tube immediately above the electric heating element containing a sensitive volatile substance which contracts and expands with the slightest change in temperature and provides a dependable action of ample power to actuate the control switch. When the water around the glue pot reaches the proper temperature (150 deg.), the control turns off the current. When the temperature falls a few degrees, the heat is turned on again. Since this action is automatic, workmen need not watch thermometers and an increase in production is the direct result.

The glue pot operates from any electric lighting circuit and is put in operation by merely turning the switch. This glue pot functions either as a water bath, hot air, or dry heat pot and whichever way it is used, does not overheat, even if the current be left on indefinitely.

General News Section

The Monitor Controller Company of Baltimore, manufacturers of automatic control devices for motor-driven apparatus have recently established a branch office at 1100 Elm street, Birmingham, Ala. William H. Noville will be in charge.

The installation of radiophones in passenger trains on the Canadian Division of the Michigan Central to assist in the efficient operation of trains and also for the convenience and entertainment of passengers is under serious consideration according to a recent report in the Toronto Globe.

The Electric Material Company, San Francisco, Cal., with branch office at Los Angeles, has been appointed agent in the State of Washington and parts of Oregon and Idaho for the Roller-Smith Company, New York. The Electric Material Company recently opened an office in the Hinckley building, Seattle, in charge of R. F. Robinson.

The Richards Train Control Corporation of Baltimore, Md., has recently been incorporated under the laws of Maryland with a capitalization of $2,000,000 for the manufacture and installation of automatic train control apparatus. This represents a reorganization of the Richards-Ford Train Control Company which was incorporated in 1917.

G. P. Atkinson, for several years connected with the sales department of the Weston Electrical Instrument Company, Newark, N. J., has established an office at Atlanta, Ga., to represent that company in Georgia, South Carolina and northern Alabama. In addition to Weston instruments, Mr. Atkinson will represent several other electrical equipment companies.

Radiophones, for transmitting news and other matter to passengers, are to be introduced on one of the fast trains of the Louisville & Nashville running between Cincinnati and New Orleans, successful experiments having been made with apparatus on a train which was run out of Louisville. The apparatus worked well while the train was in the tunnel beneath Muldraughs Hill, 300 ft. below the surface of the earth. This hill is said to contain a large percentage of iron.

The General Electric Company, Schenectady, N. Y., has set aside a fund of $400,000, the income from which will be available for encouraging and rewarding service in the electrical field by giving prizes to its employees, to public utility and electric railway companies and fellowships to students of American colleges. As an expression of appreciation to Charles A. Coffin, who retired in May, 1922, from the active leadership of the General Electric Company, the board of directors named it the Charles A. Coffin Foundation.

The third shipment of electrical equipment for the Chilean State Railway, consisting of six complete electric locomotives, recently left the East Pittsburgh Works of the Westinghouse Electric & Manufacturing Company. The shipment was valued at $700,000 and represented a partial fulfillment of the $7,000,000 contract awarded the Westinghouse International Company by the Chilean State Railways. The six locomotives in the recent shipment are of the road freight type and weigh approximately 103 metric tons each.

Plans for electrifying the Dutch Railways are included in a larger plan for electrification in Holland. The Dutch government has appointed a commission for the purpose of studying and eventually improving an electrification plan which was submitted to the government some time ago. The plan includes the erection of five large central stations to take the place of the numerous smaller ones now existing. The first line to be electrified will be that part of the Dutch Federal Railway between Amsterdam and the Hague to Rotterdam.

Announcement is made of a number of changes in the organization of the Westinghouse Electric & Manufacturing Company. F. R. Kohnstamm, who has been acting manager of the domestic heating section of the merchandising department, has been made manager of that section, and E. W. Knight, who has been acting manager of the fan section of that department, has been appointed manager of the section. A. G. Crocker has been appointed special power representative in the Detroit office of the company, and Clifford G. Hillier has been appointed manager of the merchandising division of the Boston office.

Electrification of the St. Gotthard line in Switzerland is now completed and in operation according to a report from Consul-General James J. Murphy. The report states that the installation from a technical point of view is entirely successful. The movement of trains is just as regular as with steam locomotives and the passengers and the railroad personnel highly appreciate the elimination of smoke. The strain on the rolling stock is lessened and wear on the removable parts has been found to be considerably reduced. Experience shows, however, that the greater speed obtained apparently causes an increase of wear on the outer rails on curves. The greater speed has also made possible improvements in the time tables. The efficiency of maintainers working in the tunnels has increased noticeably.

A 50-ton electric locomotive was recently purchased from the Westinghouse Electric & Manufacturing Company by the Youngstown & Ohio, which operates in the soft coal regions between East Liverpool and Salem, Ohio. The incident was remarkable in that only five hours were required for the sale, inspection and shipment of the locomotive. The day after the sale, the locomotive was at Leetonia, Ohio, and the following day was placed in service in hauling coal on the Youngstown & Ohio be-

tween Leetonia and East Liverpool. The need for the locomotive was urgent as the two locomotives which had been handling the traffic were in service continuously 24 hours a day every day, except 4 hours on Sunday, when they were taken into the shop for oiling and inspection. The quick sale and delivery were made possible because the Westinghouse company had a locomotive in stock which was capable of giving the same service as those already in use.

The United States Civil Service Commission announces an open competitive examination for Electrical Engineer to fill a vacancy in the Dredge Construction Service, Office of Chief Engineer, War Department, the position to pay from $4,000 to $6,000 a year. Applicants must have graduated from a college or university of recognized standing with a degree in engineering and in addition to that have had at least six years of subsequent progressive experience in the general design and manufacture of electrical machinery, at least four years of which must have been in the responsible design of electrical machinery for marine use. It must be shown that at least six months of the experience was acquired in a testing laboratory on electrical machinery and at least one year in connection with electrically controlled apparatus. The exact title of the examination must be included in the application. This title is, Electrical Engineer, $4,000-$6,000. Applicants should apply to the Civil Service Commission, Washington, D. C. for form No. 2118, stating the title of the examination. The receipt of applications will close December 26, 1922.

New Haven Orders Generating Apparatus

The New York, New Haven & Hartford will install a new turbine generator in its Cos Cob power station to take care of an increased load due to the placing in service of twelve new high speed passenger locomotives. The Cos Cob power station furnishes the greater part of the energy for electrified section of the railroad and putting on more locomotives will necessitate an increase in the generating equipment there to meet the increased load.

The new turbine generator is a 9,000 kw., single phase, 25 cycle unit. The turbine is designed to carry 12,500 kw. and the generator to take these peaks for a period of five minutes. The turbine will be served by a jet condenser circulating 12,000 gallons per minute. The condenser pumps are driven by a 25 cycle motor. In the order received by the Westinghouse Company for this apparatus is also included switching equipment for control of the turbine generator, exciter and auxiliaries.

British Firms Secure South African Electrification Contracts

A number of British firms have secured the contracts for the railway electrification in Natal, South Africa. The total expenditure involved is placed at £4,500,000. Among the firms participating are: Metropolitan-Vickers Electrical Co., Ltd.; C. A. Parsons & Company, Ltd.; Babcock & Wilcox, Ltd.; British Thomson-Houston Co., Ltd.; Telegraph Manufacturing Company; A. Reyrolle & Company, Ltd.; South African General Electric Company. For the automatic telephone exchange equipment contracts aggregating £100,000 have been awarded to Messrs. Siemens Brothers & Company, Ltd., of Woolwich, England.

The contracts placed with the Metropolitan-Vickers Company include seventy-eight 3,000-volt, direct-current electric locomotives, according to the Times (London) Trade Supplement for November 25, 1922. The electrical equipment for the locomotives will be built at the Sheffield works of the Vickers Company. The section of railway to be electrified extends from Glencoe to Pietermaritzburg, a distance of about 200 miles. The new locomotives are expected to be capable of making a round trip from Ladysmith to Pietermaritzburg once every twenty-four hours for six days a week, the distance being 129 miles each way.

Automatic Train-Control Orders Modified

The Interstate Commerce Commission has authorized the Central of New Jersey to install, in accordance with the terms of its order, an automatic train-stop or train-control device between Red Bank, N. J., and Winslow Junction, N. J., in lieu of the installation required upon the portion of its line designated in the order of June 13. The Great Northern has also been authorized to make an installation upon one full passenger-locomotive division between Minot, N. D., and Williston, N. D., in lieu of the installation required in the order. The petition of the Richmond, Fredericksburg & Potomac for a modification of the order with respect to certain requirements was denied.

Largest Railway Mail Terminal

The largest mail terminal station in the world was put in operation on December 3, when the Chicago Post Office took possession of the new building at Van Buren street and the Chicago river, Chicago, erected for it by the Chicago Union Station Company. The building is 800 ft. in length and contains belt conveyors, automatic hoists, pneumatic tubes, tilting parcel dumps, and other mechanical devices to aid in the handling of mail. It is equipped to care for 3,000 tons or 100,000 sacks of parcels a day. The building has direct loading facilities on track level for the Chicago, Burlington & Quincy, the Chicago, Milwaukee & St. Paul, the Chicago & Alton and the Pennsylvania.

Radio Records Broken

Forty-five seconds from London, fifty-five from Norway, a little longer from France and two minutes and forty seconds from Germany—these were the periods of time taken to receive answers by radio to dispatches inquiring about the weather sent from the Engineering Societies building, New York City, under the direction of David Sarnoff recently. Mr. Sarnoff spoke before the New York Electrical Society, which was holding its regular monthly meeting, and predicted the coming of a "wrist-watch wireless set, or radiolet," by means of which "a man could receive in his vest pocket market reports, weather reports and details of championship games."

On the same day all amateur long-distance records were said to have been shattered at the radio station of Hiram P. Maxim, president of the American Radio Relay League, when a radiogram was sent to Wailuku, Hawaiian

Islands, and the answer was received in four minutes and eighteen seconds. The radiogram was relayed at Sleepy Eye, Minn. The distance from Hartford to Sleepy Eye by air line is about 1,200 miles, and thence to Wailuku 4,000 miles.

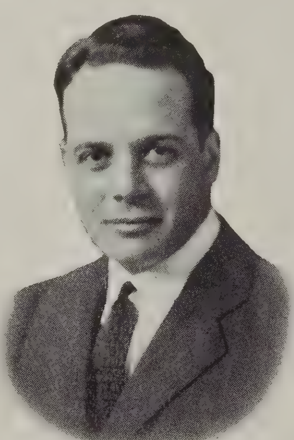
P. R. R. Improvements at Pitcairn

The Pennsylvania has just completed and placed in service at Pitcairn, Pa., a modern 34-stall enginehouse with a turntable at a cost of $1,385,000. This terminal is located on the main line of the Central Region and is one of the key positions of the system in expediting the movement of through trains. Nearly 200 engines are handled daily.

In addition to preparing the engines for service the heaviest of running repairs will be made at Pitcairn. Among the important facilities at the new enginehouse is the turntable, 110 ft. long and electrically operated. Each stall is 140 ft. long and so constructed that it can be completely enclosed. The structure is steam heated.

Personals

R. S. Gay, formerly sales representative in Chicago for Beal Bros. and Beal Tool Company and more recently manager of Hubbard and Company's plant at Montpelier, Indiana, has been appointed representative of the Safety Car Heating & Lighting Co., with headquarters in Chicago. He was born in Orleans, Neb., September 2, 1888. He first entered railway service in June, 1910, on the Chicago, Burlington & Quincy in the bridge department, being assigned to the construction and design work. He later served in the inspection department of the Atchison, Topeka and Santa Fe with headquarters in St. Louis, Mo. After leaving the Santa Fe he returned to school and graduated from the School of Civil Engineering of Purdue University in June, 1911. After graduation he entered the service of the Beal Bros. and the Beal Tool Company of Alton, Ill., as their Chicago representative. When these two companies were absorbed by the Hubbard Company Mr. Gay was transferred to Montpelier, Ind., as manager of the Hubbard & Co. plant at that point. He resigned this position in March, 1922, and accepted his new appointment as noted above on November 1, 1922.



R. S. Gay

R. W. Everson, sales manager of the Mexican branch of the Westinghouse Electric International Company has been appointed district manager of the Atlanta office of the Westinghouse Lamp Company. He succeeds Julien Binford, Jr., resigned.

Mr. Everson has been associated with the Westinghouse industries for more than twenty-four years and has held a number of important positions. For several years he was in charge of the supply department of the electric company and in 1906 was transferred to the Chicago district office as sales representative specializing on syndicates.

In 1918 he was made manager of the merchandising department of the International company, supervising merchandising sales in foreign countries. In 1921 he left for Mexico to be sales manager of the Mexican branch of that company, which position he held until his recent appointment.

E. D. Lynch, railway department, Westinghouse Electric & Manufacturing Company, has recently been transferred to the New Haven office of that company. Mr. Lynch has been engaged in railway activities since graduating from the Baltimore Polytechnic Institute.

His first practical experience was obtained when he was in the employ of the Westinghouse service department at Chicago. Mr. Lynch came to the East Pittsburgh works in 1910, entering the two-year student course in shop work. Immediately upon the completion of the course, he became attached to railway department, where he has been constantly in general touch with the problems and conditions that have directed the development of the railway industry. He was engaged in assisting in the negotiation work of the railway department, but at a reorganization of the railway department he was appointed office manager of the department.

At New Haven Mr. Lynch will fill the vacancy made by J. P. Alexander's removal to the Boston office of the company. Besides being active in the railway industry, Mr. Lynch was very actively engaged in promoting the social activities of the Westinghouse Club, one of the company's social organizations.

Obituary

William T. Brown, retired consulting electrician in the secretary's department, Pennsylvania Railroad, died on October 12, 1922. His name had been on the Railroad "Roll of Honor" since April 1, 1915, when he was relieved from active duty, under the pension regulations, with a long record of forty-eight years and seven months of service.

Mr. Brown started to work for the Pennsylvania at the age of twelve years, as messenger boy. He learned telegraphy, and at the age of fourteen was placed in charge of the telegraph station at Bridgeton, N. J. He was transferred to the general agent's department, as telegraph operator, and on January 1, 1868, he became private operator to President Thomas A. Scott. The following year he was assigned to the Walnut street office, as manager-operator, and on April 1, 1872, he was transferred to the telegraph department of the general office as telegraph operator. He was appointed manager of this telegraph office on March 13, 1876. Three years later he was advanced to electrician, and on June 1, 1894, he was transferred to the secretary's department as electrical engineer.

Mr. Brown had general charge of the electrical work of the general offices of the railroad. He assisted the chief engineer in many electrical installations. On February 1, 1909, Mr. Brown was appointed consulting electrician.

Railway Engng

[UNIV]ERSITY OF ILLINOIS LIBRA[RY]

DEC 26 1922

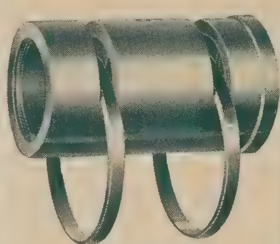
Railway Electrical Engineer

DECEMBER, 1922

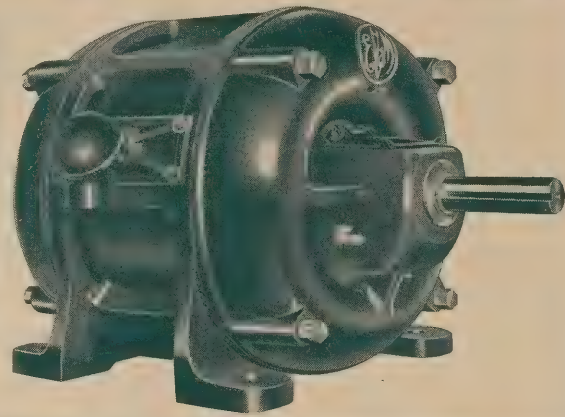
May we express the hope that your Christmas stockings will be filled to overflowing; and that the year 1923 be one of health, happiness and prosperity.

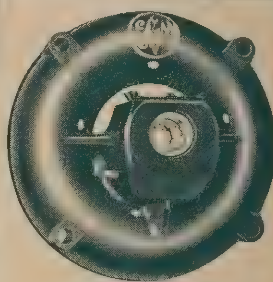
The Publisher

NO LUBRICATION TROUBLES



BEARING





END SHIELD

TYPE NC MOTOR

Every care has been taken to prevent the two most important troubles with motor bearings.

1—TROUBLE WITH IMPROPER LUBRICATION. Every bearing on a Type NC Motor has two oil rings. One ring is sufficient to oil the bearing. The second ring is a factor of safety. All oil wells are made larger than engineering practice demands.

2—OIL WORKING OUT OF BEARING AND CAUSING TROUBLE IN STATOR COILS. The oil rings and wells are so designed that no oil is thrown onto the bearing cover and oil is only found in the oil well and on the shaft. Double oil slingers with large return ducts are used so that oil does not escape along the shaft. There is therefore no oil vapor or loose oil to be sucked into the motor by the fan action of the rotor.

Write for Catalogue 1045

THE ELECTRIC CONTROLLER & MFG. CO.

CLEVELAND, OHIO

BIRMINGHAM-BROWN-MARX BLDG.
CHICAGO-CONWAY BLDG.
CINCINNATI-1ST NATIONAL BANK BLDG.
DENVER-ENGINEERS BLDG.
DETROIT-DIME BANK BLDG.
LOS ANGELES-O. E. THOMAS CO. AMERICAN BANK BLDG.
NEW YORK-50 CHURCH ST.
PHILADELPHIA-WITHERSPOON BLDG.
PITTSBURGH-OLIVER BLDG.
SAN FRANCISCO-CALL BUILDING
SEATTLE-524 1ST AVE. SOUTH
TORONTO-TRADERS BANK BLDG.

Volume 13 Number 12

Published Monthly by Simmons-Boardman Publishing Co., Woolworth Building, New York, N. Y. Subscription price, United States, Canada and Mexico, $2.00 a year; foreign countries, $3.00 a year. Single copies, 35 cents. Entered as second-class matter, January 4, 1916, at the post office at New York, N. Y., under the act of March 3, 1879.

Typical bank of Packard Transformers.

Care of Transformers

Abuse and Neglect in Service Are the Causes of Most Transformer Failures

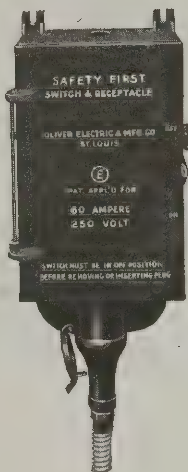
The first consideration in giving your Transformers a square deal is to see that they are properly fused. As an aid towards this end we have had assembled on a celluloid card that will fit the ordinary card case a tabulation of full load current values of the complete range of single Phase Distribution Type Transformers up to 200 KV-A 33,000 Volts.

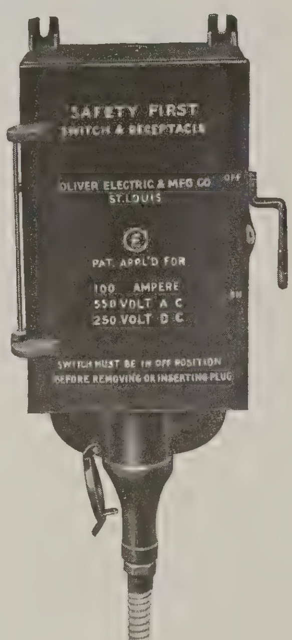
We shall be pleased to send you as many of these cards as needed for your organization.

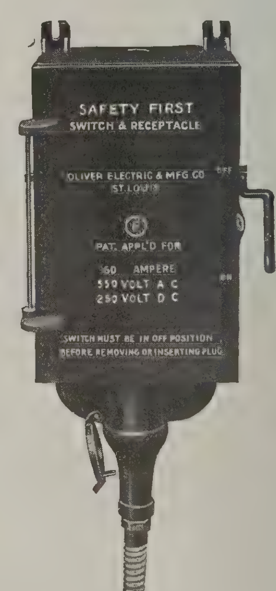
The Packard Electric Company

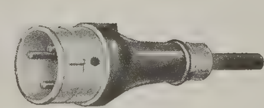
Warren, Ohio

Safety First Switch with Receptacle and Interlocking Plug

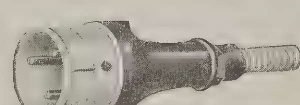




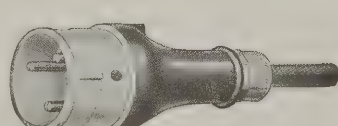




60 AMP. 250 VOLT



60 AMP. 500 VOLT



100 AMP. 500 VOLT

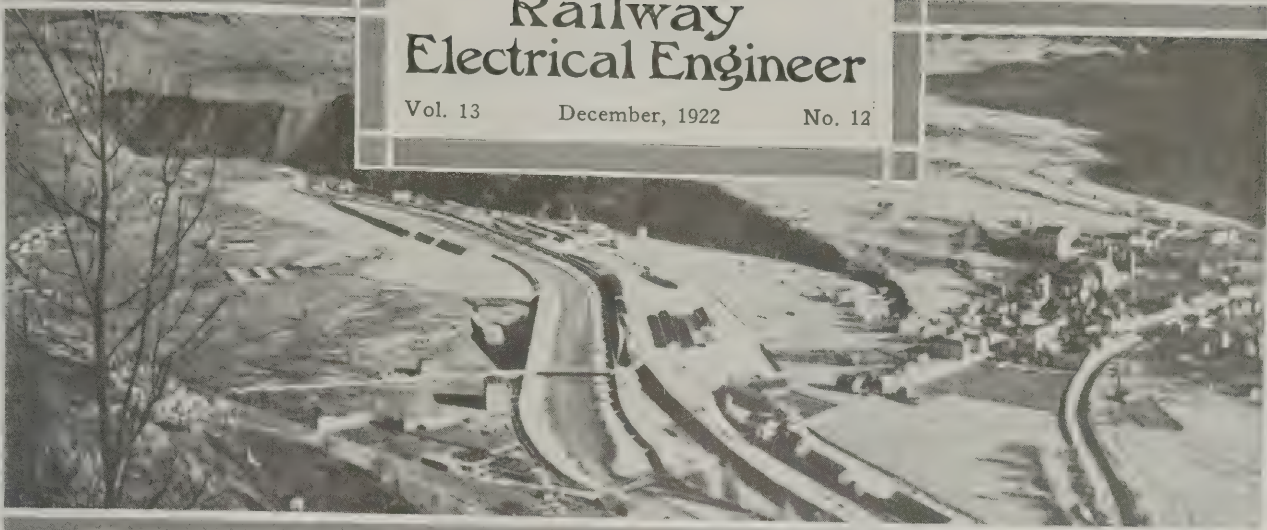
WRITE FOR CATALOG NUMBER 300

OLIVER ELECTRIC AND MANUFACTURING CO.

SAINT LOUIS, U. S. A.

Railway Electrical Engineer

Vol. 13 December, 1922 No. 12



Brieg, Switzerland, the Northern Terminus of the Simplon Tunnel, Which Has Just Been Duplicated—Photo by International

Contents

Published on the second Thursday of every month by the

Simmons-Boardman Publishing Company, Woolworth Building, New York

EDWARD A. SIMMONS, *President* HENRY LEE, *Vice-Pres. & Treas.* C. R. MILLS, *Vice-Pres.*
L. B. SHERMAN, *Vice-Pres.* SAMUEL O. DUNN, *Vice-Pres.* ROY V. WRIGHT, *Sec'y.*

CHICAGO: Transportation Building CLEVELAND: 4300 Euclid Ave. LONDON, England: 34, Victoria St., Westminster, S. W. I. Cable address: Urasigmec, London
CINCINNATI: First National Bank Building WASHINGTON: Home Life Bldg. NEW ORLEANS: Maison Blanche Annex

E. A. LUNDY, Business Manager, Cleveland

ALFRED G. OEHLER, Editor.
CHAS. J. CORSE, Managing Editor. J. H. DUNN, Associate Editor

Subscription, including postage: United States, Canada and Mexico, $2.00 a year; Foreign Countries, $3.00 a year; single copy, 35 cents. Foreign subscriptions may be paid through our London office (34 Victoria Street, S. W., 1), in £—s—d.

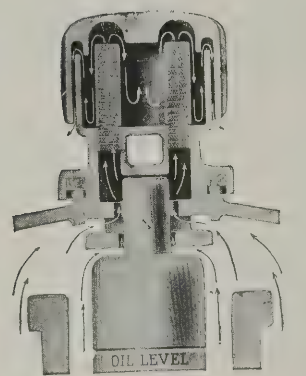
Entered as second class matter, January 4, 1916, at the post office at New York, New York, under the act of March 3, 1879.

WE GUARANTEE, that of this issue 2,700 copies were printed; that of these 2,700 copies 2,001 were mailed to regular paid subscribers, 4 were provided for counter and news company sales, 49 were mailed to advertisers, 28 were mailed to employees and correspondents and 618 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 31,950, an average of 2,663 copies a month.

REQUEST for change of address should reach us two weeks before the date of the issue with which it is to go into effect. It is often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your OLD address as well as the NEW one.

The Railway Electrical Engineer is a member of the Associated Business Papers (A. B. P.) and of the Audit Bureau of Circulation (A. B. C.)

D & W Oil Fuse Cutouts



Method of Venting

Oil fuse cutouts to successfully operate must be properly vented. D & W Oil Fuse Cutouts, both pole and subway type, have unique and successful venting systems.

In the pole type the gas formed from the blowing of the fuse link travels upward around the carrier, taking with it a certain amount of oil. As this froth enters the tubes located under the cap it encounters a series of screen baffle plates. The contact with these screens, together with the impact of the foam against the rounded deflectors of the cap, sets free the gas which passes out from under the base of the cap by an indirect path. The oil being unable to follow the circuitous route is deflected into the reservoir from which it drains back into the tank by means of the capillary holes drilled into the base of the brass tubes.

In draining back to the tank a permanent film of oil is left in the holes which forms an effective seal against the entrance of water or moisture which might condense within the reservoir.

Our new bulletin, Catalogue No. 6004, gives complete information and will be sent upon request.

MANSON TAPE

The Standard for Friction Tape

ONE QUALITY ONLY

Manson Tape is a tough durable cotton fabric into which has been frictioned (not spread) the highest quality friction (sticky), rubber compound. It is intended primarily for the mechanical protection of wire and cable splices, but can be used for any purpose demanding a high quality friction tape.

Manson Tape is strongly adhesive, does not unwrap, and does not corrode copper wire.

Made in two colors, black and white.

Standard stock package is ½ pound of ¾″ black tape, but any width and any weight roll can be furnished.

OKONITE TAPE

The Standard for Rubber Insulating Tape

ONE QUALITY ONLY

Okonite Tape is an unvulcanized rubber compound tape for insulating splices in wires and cables. It is made with the same high-grade rubber, compounding ingredients, and care that characterize Okonite Insulation.

As Okonite Tape is unvulcanized, it readily moulds into a homogeneous mass, and makes the splice impervious to moisture and the equal electrically and mechanically of the insulated wire itself.

Okonite Tape has no equal and should always be used to obtain perfect splices.

Standard stock package is ½ pound of ¾″ tape, but any width and any weight roll can be furnished.

Central Electric Company

FOUNDED 1887

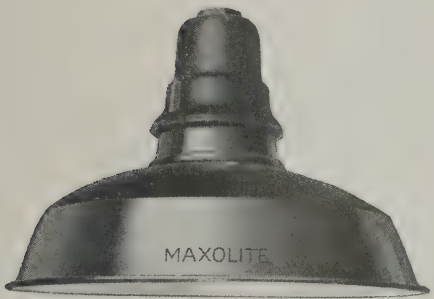
The House of Service

316-326 South Wells Street

CHICAGO

MAXOLITE

The Trade-Mark of Illuminating Efficiency



The Maxolite threaded line is brought out particularly for out-door application around railroad properties such as shops, yards, freight platforms, and other places where it is desirable to take down reflectors to give them a thorough cleaning. They may also be applied in certain interiors where the removable and interchangeable feature is desirable.

The hoods are furnished for mounting direct upon outlet boxes or to hang from conduit stem. The latter is regularly tapped for ½″ conduit or will be furnished for ¾″ without additional cost. Hoods are furnished in blue enamel to match reflector.

Reflectors are RLM standard dome, blue outside, white inside. A heavy copper collar threaded to fit the hood is inserted in the neck of the reflector.

HOODS FOR OUTLET BOX

Maxolite outlet box type hoods are threaded in the same way as the pendant hood but are made to fit the standard 4″ outlet box.

ATTALITE

A Totally Enclosed Dust-Proof Unit of High Efficiency and Correct Light Distribution

Our experience in the designing of lighting glassware and fixtures for office buildings and certain kinds of manufacturing plants has indicated the need for an enclosed type of unit which would require but little maintenance and distribute the light downward to the place where it is wanted.

The round opal ball, the acorn globe and the hemispherical globe with flat top all throw too large a quantity of light in a horizontal direction, thus wasting it on the walls. In the Attalite this difficulty has been overcome.

It is very shallow in comparison to its diameter, and the angle of the upper surface of the globe is such that it tends to reflect light down through the lower portion. Because of these two points of design a very large percentage of the light is thrown directly to the working plane and is not wasted on the walls. The image of the lamp filament is completely broken up, the glass is uniformly lighted, and the total light output is over 82%.

The canopy and holder are of heavy gauge brass. The set screws are unusually large assuring a reliable holder. The Attalite can be supplied in both pendant and ceiling types, the former having a chain of liberal size. Standard finish is a rich statuary bronze, but can also be furnished in brush brass, French grey, ivory or any other finish desired.

The Attalite is extremely popular in railroad circles, due to its low upkeep and remarkably low price. It has truly been called: "A better light for less money."

Prices and data supplied immediately on request.

Central Electric Company

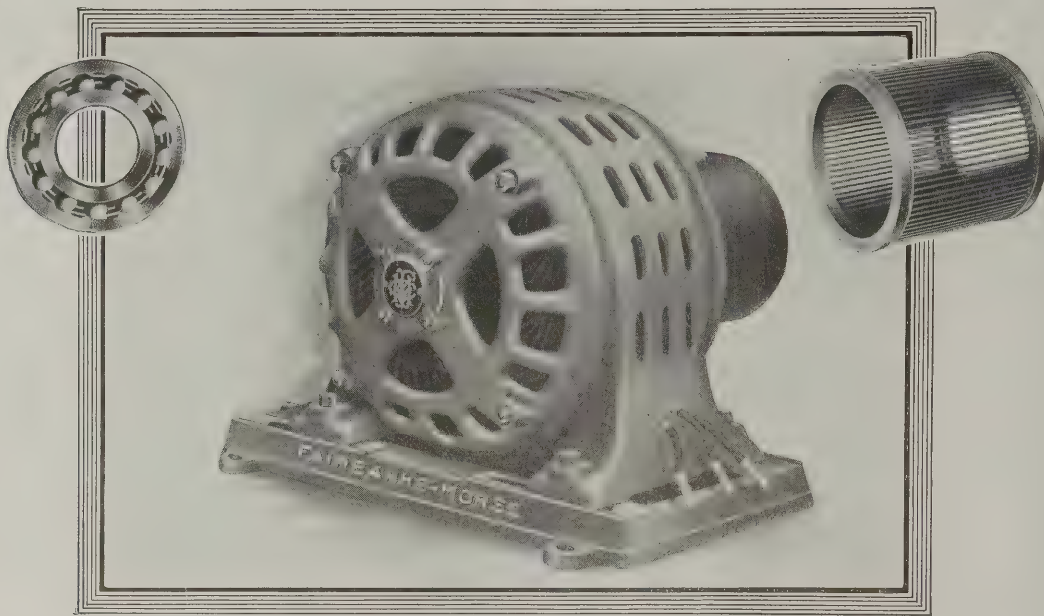
FOUNDED 1887

The House of Service

316-326 South Wells Street

CHICAGO

Fairbanks-Morse Ball Bearing Motors



These Big Features Cut Current Bills and Assure Long Service

Service records prove the following advantages for Fairbanks-Morse Ball Bearing Motors:

—High current economy
—low maintenance cost
—few repairs
—little attention required
—no lubrication troubles

The solid one piece rotor winding with end rings cast on solid copper bars gives mechanical strength and high conductivity.

Solid one piece cast frame—rigid base with broad feet cast on.

Standard 40 degree rating gives a factor of safety and an assurance of service when the actual load is not definitely known.

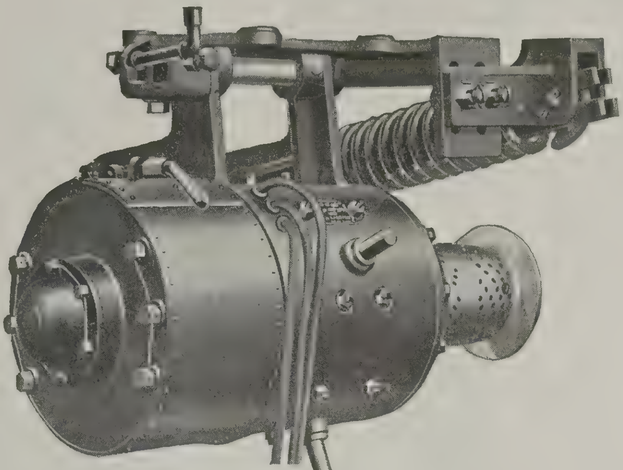
FAIRBANKS-MORSE QUALITY F M 100%

Fairbanks, Morse & Co.

MANUFACTURERS CHICAGO

Canadian Fairbanks-Morse Co., Ltd., Montreal

Oil Engines - Pumps - Electric Motors and Generators - Fairbanks Scales - Railway Appliances - Farm Power Machinery



Standard Safety "Under-Frame" Car Lighting Generator

The "Know How" Of Car Lighting

The business of this Company is the manufacture and sale of car lighting equipment. But what we really sell — and what the Safety customer really buys—is illumination. Safety Car Lighting Equipment is but a physical nucleus about which is built a system of making and distributing and applying light under conditions of peculiar difficulty. It is this system which you, as a Safety customer, will buy—not merely the equipment about which it centers. And the intangible, invisible elements of this system can perhaps be best defined as "the know-how" of car lighting. This is an added value in a Safety System for which there is no charge—indeed, upon which no price could be placed.

Complete Car Lighting Electric and Pintsch Gas Systems; Steel Lighting Fixtures; Electric Water Heaters for Washrooms; Electric Water Coolers for Coaches; Electric Ceiling, Bracket and Exhaust Fans; Train Lighting Storage Batteries.

MANUFACTURED AND SOLD BY

THE SAFETY CAR HEATING AND LIGHTING COMPANY

2 Rector Street, New York, U.S.A.

Chicago Philadelphia St. Louis San Francisco Boston Montreal

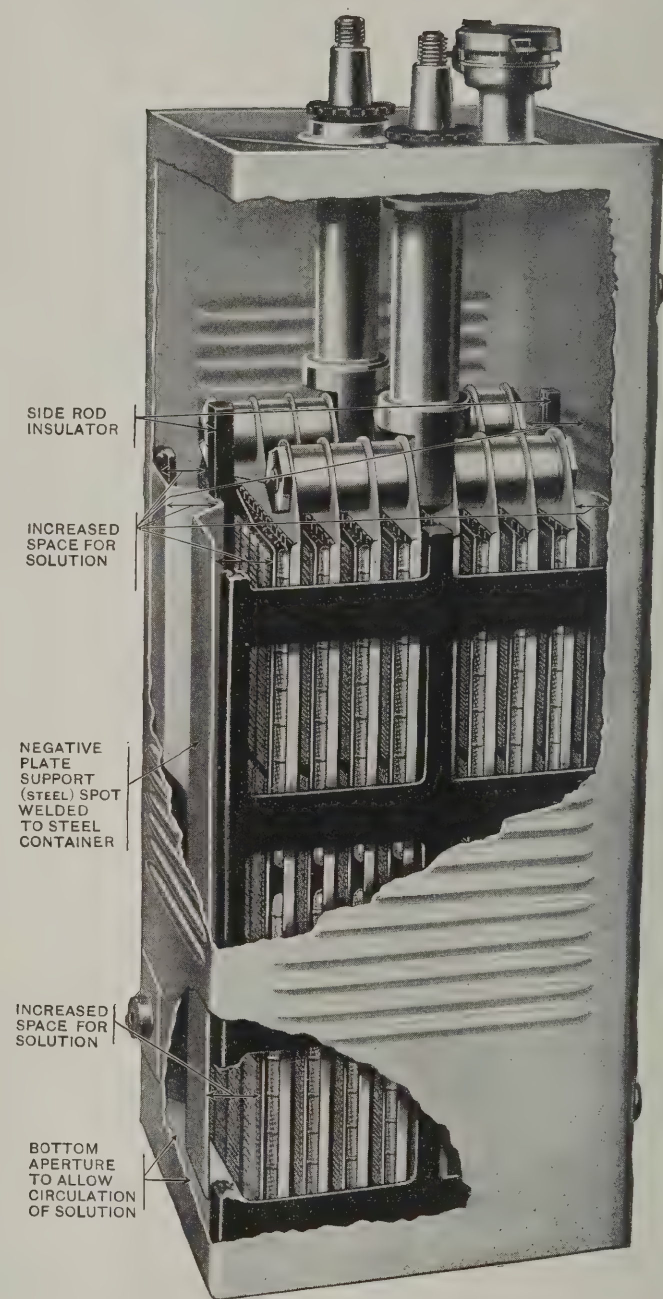
Improved Car Lighting Service With New Edison HW Cell

The increased volume of electrolyte in the New Edison H W* Cell, permits higher rates of charge at lower temperature with minimum evaporation.

It is characteristic of Edison Batteries that the specific gravity does not vary with any state of charge or discharge. Therefore, the high setting of axle generator regulators does not cause a wide range in specific gravity, and frequent equalization of solution is unnecessary.

Bulletin 118 shows all the advantages of Edison Batteries in Car Lighting. Your copy sent on request.

*High Wide



New HW Cell

1—Increased space for electrolyte is provided.

2—Circulation and radiation are improved.

3—The wide range in specific gravity, due to evaporation, is eliminated.

4—The periods between flushings are doubled.

5—Voltage characteristics are improved and capacity increased.

Edison Storage Battery Company

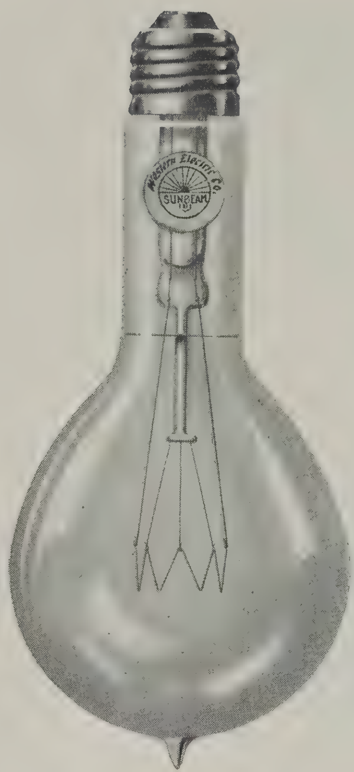
Factory and Main Office: ORANGE, N. J.

DISTRIBUTORS IN

New York Boston Chicago Detroit Seattle San Francisco Los Angeles New Orleans
St. Louis Pittsburgh Washington Atlanta Philadelphia Cleveland Montreal

Where Sunbeam Mazda Lamps and *Western Electric* Lighting Specialists can be located

New York
Brooklyn
Newark
Syracuse
Buffalo
New Haven
Boston
Providence
Pittsburgh
Philadelphia
Atlanta
Savannah
New Orleans
Birmingham
Jacksonville
Richmond
Norfolk
Charlotte
Youngstown
Chicago
Indianapolis
Detroit
Milwaukee
Grand Rapids
Cleveland
Minneapolis
St. Paul
Duluth
Baltimore
Kansas City
Oklahoma City
St. Louis
Memphis
Omaha
Cincinnati
Columbus
Nashville
Dallas
Houston
San Francisco
Oakland
Los Angeles
Seattle
Portland
Spokane
Tacoma
Denver
Salt Lake City



Sunbeam Mazda Lamps

for

Every R. R. Need

Flood Lighting
Car Lighting
Locomotive Cabs
Head Lights
Station Lighting
Platform Lighting

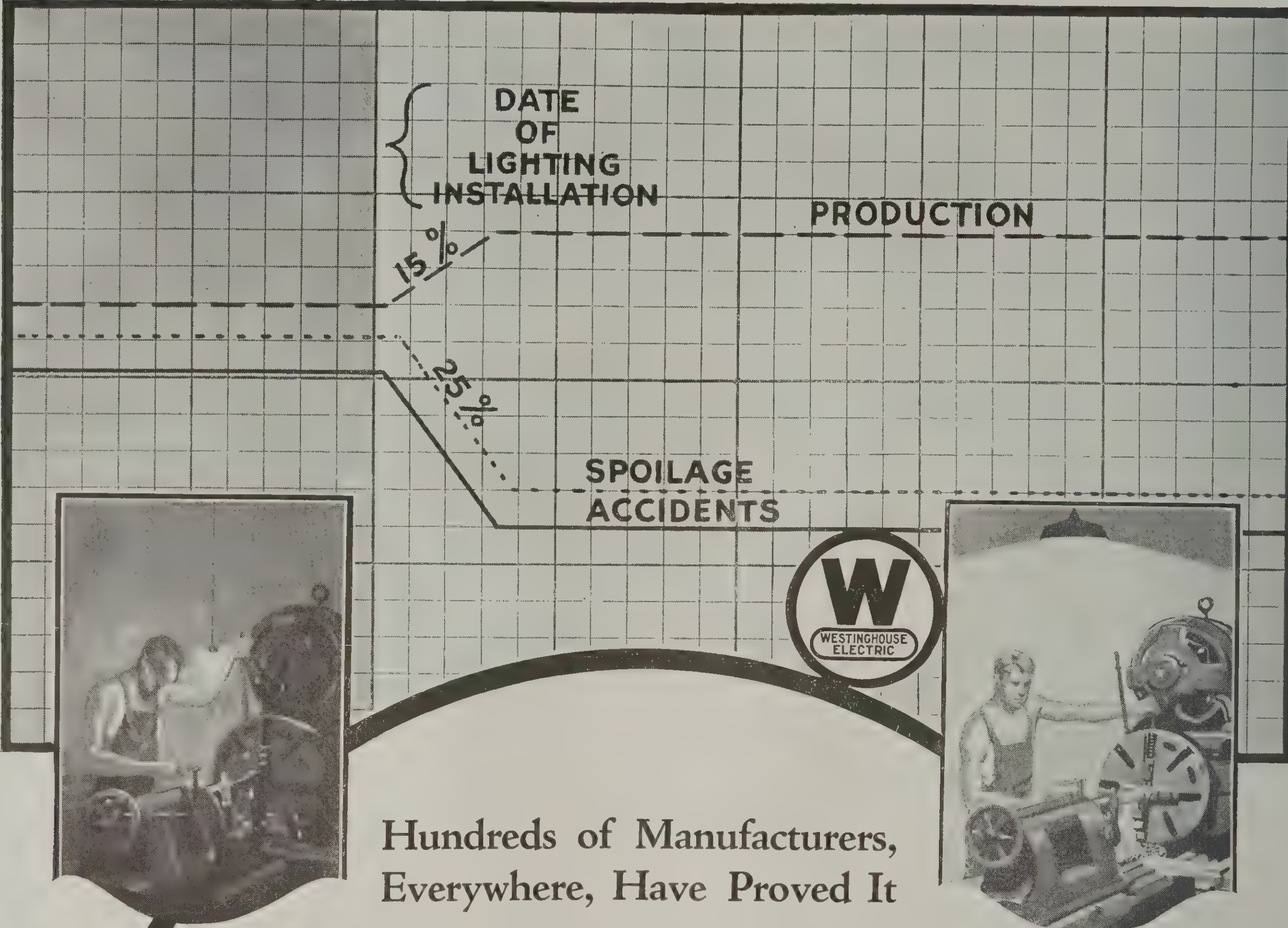
Lamp stocks are maintained at our 48 Distributing Houses in R. R. centers and through these Houses the services of our Lighting Specialists are offered.

A NATIONAL ELECTRICAL SERVICE FOR RAILROADS

Western Electric Company

OFFICES IN ALL PRINCIPAL CITIES

Better Lighting DOES PAY



Hundreds of Manufacturers, Everywhere, Have Proved It

There is no story in the whole range of electrical development that is more clean-cut, or more easily verified, than the story of what good lighting brings to a factory. The facts are so easily understood, so impressive, and it is so easy to benefit from them, that every manufacturer can find possibilities of profit in them for his own business.

It is impossible in an advertisement, to touch upon all the benefits that follow the installation of scientific lighting. All that we can do here is to call attention to the three most important results that modern lighting methods have produced. The figures used are averages from literally hundreds of installations, and are, therefore, not only conservative, but reliable.

Manufacturers have invested in money and effort many times the amounts necessary to assure the rate of *production increase* that better lighting will give. *They* have spent, and are spending, thousands annually to *reduce spoilage* and *minimize rejects.* Every plant in this country should be, and is, vitally and financially interested in the *reduction of accidents. Scientific methods of lighting offer real gains to every manufacturer under each of these three headings.*

For the sake of your workers, and for the good of your business, get into touch with the nearest Westinghouse office, where the Illumination Bureau will gladly give you the established facts, as well as an accurate estimate of what better lighting would do for your own plant.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY
GEORGE CUTTER WORKS SOUTH BEND, INDIANA

Westinghouse

© 1922 W. E. & M. Co.

Alternating-Current Electrification

Many of the most important railroads in the United States have adopted the alternating-current system. The electrifications illustrated below are representative of every type of service.

Pennsylvania System

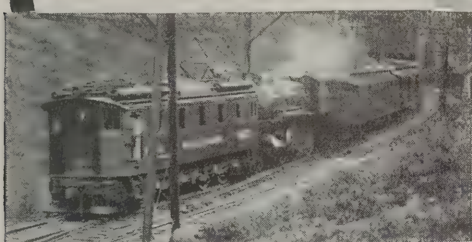
The main-line electrification of the Pennsylvania System at Philadelphia is an example of heavy multiple-unit service which has solved the problem of terminal congestion.

New York, New Haven & Hartford Railroad

High-speed freight and passenger service is maintained economically on the main line of the N.Y., N.H. & H. R.R. by use of the alternating current system.

Norfolk & Western Railway

The Norfolk & Western Electrification presents an example of the alternating-current locomotive employed successfully to handle heavy freight trains at the maximum speed on mountain grades.



New York, Westchester & Boston Railway

Rapid and efficient handling of suburban traffic is exemplified by the multiple-unit electrification of the New York, Westchester & Boston Railway.

Boston & Maine R. R.—Hoosac Tunnel

The alternating locomotive has been used advantageously by the Boston & Maine R. R. in overcoming the smoke conditions and increased traffic demands in the second largest tunnel in the world.

Erie Railroad

High-class interurban service is maintained under the severe weather conditions of the lake regions by the multiple-unit trains of the Erie Railroad.

Grand Trunk Railway

The alternating-current electrification in the St. Claire Tunnel links Canada and the United States with through-train service.

Westinghouse Electric & Manufacturing Co.

East Pittsburgh, Pa.

Westinghouse

Worn out—
Five years too soon

How can you afford to keep the constant-current system?

Continual overcharging and undercharging soon destroy car-lighting batteries.

Batteries which otherwise would last eight or nine years must be scrapped in three or four.

Will you permit this waste to go on? You can stop it at once by installing equipment that neither overcharges nor undercharges.

Investigate the Exide Axle Lighting System.

With it, excessive overcharge and gassing are entirely eliminated. When nearly discharged, the battery is recharged at a rapid rate. This rate, however, tapers off as the battery fills up, in such a manner as to keep just below the gassing point. Then, as the battery comes up to capacity, current input is gradually reduced to a low trickling rate sufficient to keep the cells fully charged, but insufficient to injure the plates even if maintained indefinitely.

Write for our Bulletin 186, which describes this equipment that enables batteries to go for *five, six, and seven years without removal from the car.*

THE ELECTRIC STORAGE BATTERY COMPANY
Philadelphia
Branches in Seventeen Cities
Manufactured in Canada by Exide Batteries of Canada, Limited, 133-157 Dufferin Street, Toronto

Exide E.S.B.

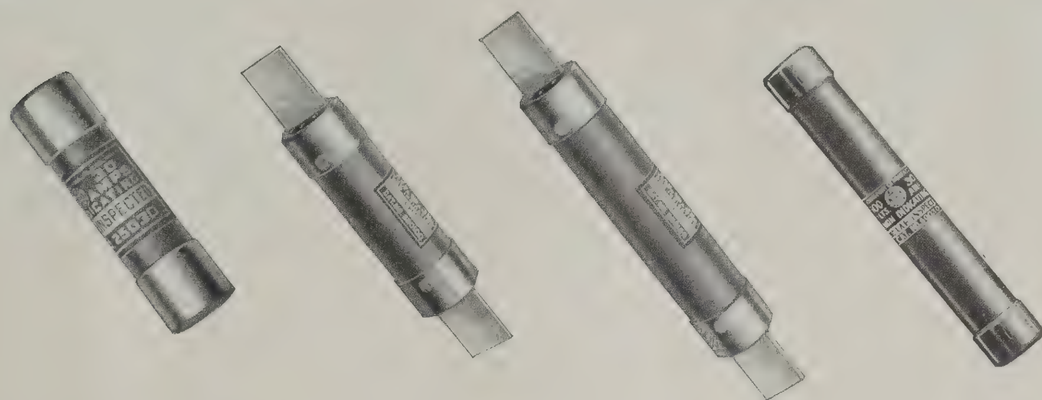
AXLE LIGHTING SYSTEM

NO ADJUSTMENTS
TWO MOVING PARTS

EVERY FUSE TESTED
NOARK
EVERY FUSE APPROVED

J-P.Co. NOARK FUSE REG. IN U.S. PAT. OFF.

PROTECTION NOARK SERVICE JP VULCABESTON



Worthy of their name—*and of your trust*

Noark NON-INDICATING FUSES are new-comers to the Noark line.

But they are every whit worthy of their name—and of your trust. The one thing connotes the other.

Noark Fuses will never be cheapened at the expense of quality.

You cannot buy a Noark Fuse designed for service where protective equipment of another type should be used.

But you can buy a Noark Fuse designed to serve every purpose for which fuses should be used. And in such service you can rely absolutely on the *dependable protection* afforded by Noark Fuse performance.

Whether your requirements are for fuses of 1 ampere capacity or 1,000 amperes—fuses for a 6-volt automobile lighting circuit, 110-volt house lighting service, a 220, 440 or 600-volt power line, a 2200, 4400, 6600 or 13,000-volt transmission line—or any other standard voltage, amperage or class of service—there is a Noark Fuse exactly adapted to your requirements.

Noark Fuses are made with ferrule contacts, knife-blade contacts, post contacts, flush contacts, variously modified for differing service applications, and are supplied in all ratings desired with these respective types.

Noark service is *your* service for every electrical protective problem.

THE JOHNS-PRATT COMPANY, HARTFORD, CONN.

NEW YORK
41 East 42nd Street

BOSTON (9)
161 Summer Street

SAN FRANCISCO
Call Building

ST. LOUIS
Boatmen's Bank Bldg.

CHICAGO
35 So. Desplaines St.

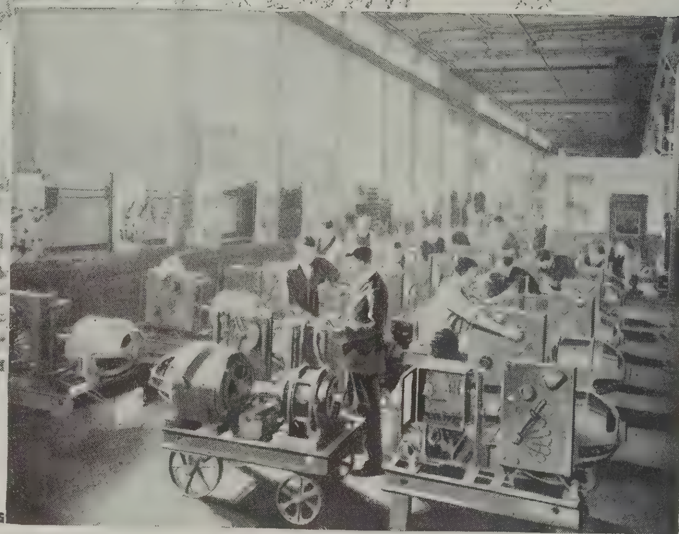
PITTSBURGH
Bessemer Bldg.

PHILADELPHIA
Franklin Trust Bldg.

Johns-Pratt

NOARK FUSES AND PROTECTIVE DEVICES VULCABESTON PACKING AND INSULATION JOHNS-PRATT MOLDED PRODUCTS

1920 4



Assembling G-E Arc Welding Sets in factory of General Electric Company.

The Railroader defines Service as the ability to transport people and things in safety and on scheduled time. His vast forces are constantly employed in the accomplishment of this purpose. His huge terminals are stupendous shows to the public of service to them.

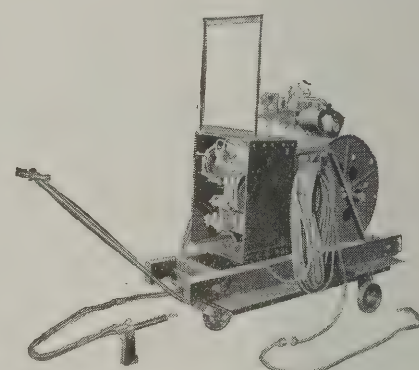
Not so apparent but of vital importance is the service of the General Electric Company to Railroads

—in its manufacture of arc welding sets;

—in its development of new arc welding equipment to meet the increasing needs of the industry;

—in its education of men who desire to become skilled arc welders.

All of these factors contribute in great measure to the enormous activities behind the scenes of the big railroad show—in roundhouses and in repair shops—facilitating engine and car repairs at a cost far below that of other methods.



G-E Portable Semi-Automatic Arc Welder is the latest development in the field of electric arc welding.

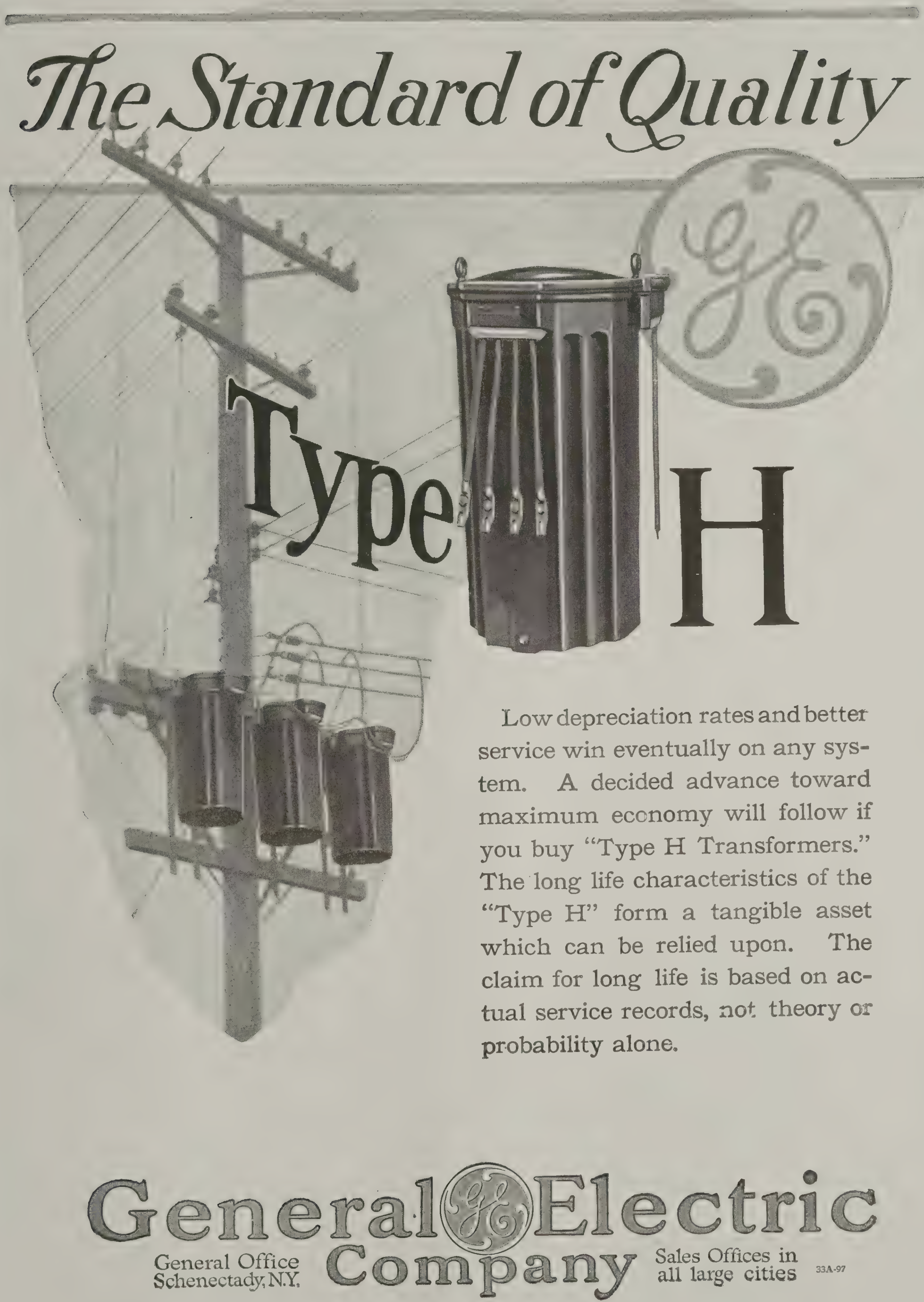
General Electric Company's Arc Welding School at Schenectady is available to any man desiring a practical course in electric arc welding.

General Electric Company

General Office Schenectady, N.Y.

Sales Offices in all large cities

43B-666


The Standard of Quality
Type H
Low depreciation rates and better service win eventually on any system. A decided advance toward maximum economy will follow if you buy "Type H Transformers." The long life characteristics of the "Type H" form a tangible asset which can be relied upon. The claim for long life is based on actual service records, not theory or probability alone.
General Electric Company
General Office Schenectady, N.Y.
Sales Offices in all large cities
33A-97

TRAIN LIGHTING
SFC
ENGINEERS

A Logical Car Lighting System

WHAT should govern the charging of a train lighting battery?

The condition of the battery, naturally.

This is accomplished in the Stone-Franklin system by having the battery itself control the rate and amount of the charge.

Only two instruments are necessary:

First, the Reducer, a switch that reduces the charge rate when the gassing point is reached.

Second, the Cutout, a device that cuts out the battery absolutely, regardless of train speed, when full charge is attained.

Service results on over thirty railroads are proving daily the advantages of a system in which battery characteristics control battery charging.

Write for complete information.

Stone-Franklin's staff consists of trained railroad men. They welcome the opportunity of consulting with railroad representatives concerning train lighting problems, as it is by such co-operation that the Stone-Franklin Car Lighting System has been developed to its present state of advancement.

Stone Franklin Company

17 East 42nd St.
New York

6400 Plymouth Ave.
St. Louis, Mo.

Transportation Bldg.
Montreal

Must a battery be handled in the yards?

You need not handle the Exide Battery in the yards, even to flush it. A special celluloid float enables the battery man to see readily whether the battery requires flushing and when it is flushed enough. Simply drop this float in the vent opening; it remains in the cell even when the vent cap is in place. We will gladly send you one as a sample.

Exide plates need no repairs, for they are rugged enough to stand the strain of railroad service. Repairs of another sort are also not required, as the Exide is free from leaky cells. The Exide Non-conductive Container, made of rubber compound, takes care of that. Neither are Exide plates the cause of expensive handling. They require no periodic cutting down, because they do not grow.

High final voltage means more light

As long as the voltage of a car-lighting battery remains high, the lamps in the car will shine brightly. The lamps in an Exide-equipped car remain bright to the end of the discharge period, because the Exide's final voltage is high.

Unexpected lamp failures can be prevented

It is easy to tell when an Exide Battery needs recharging. Here is what happens: At the end of the discharge period, the battery continues to supply some current to the lamps, but not enough to keep them quite as bright. The inspector, seeing the light lower, knows at once that recharging is necessary.

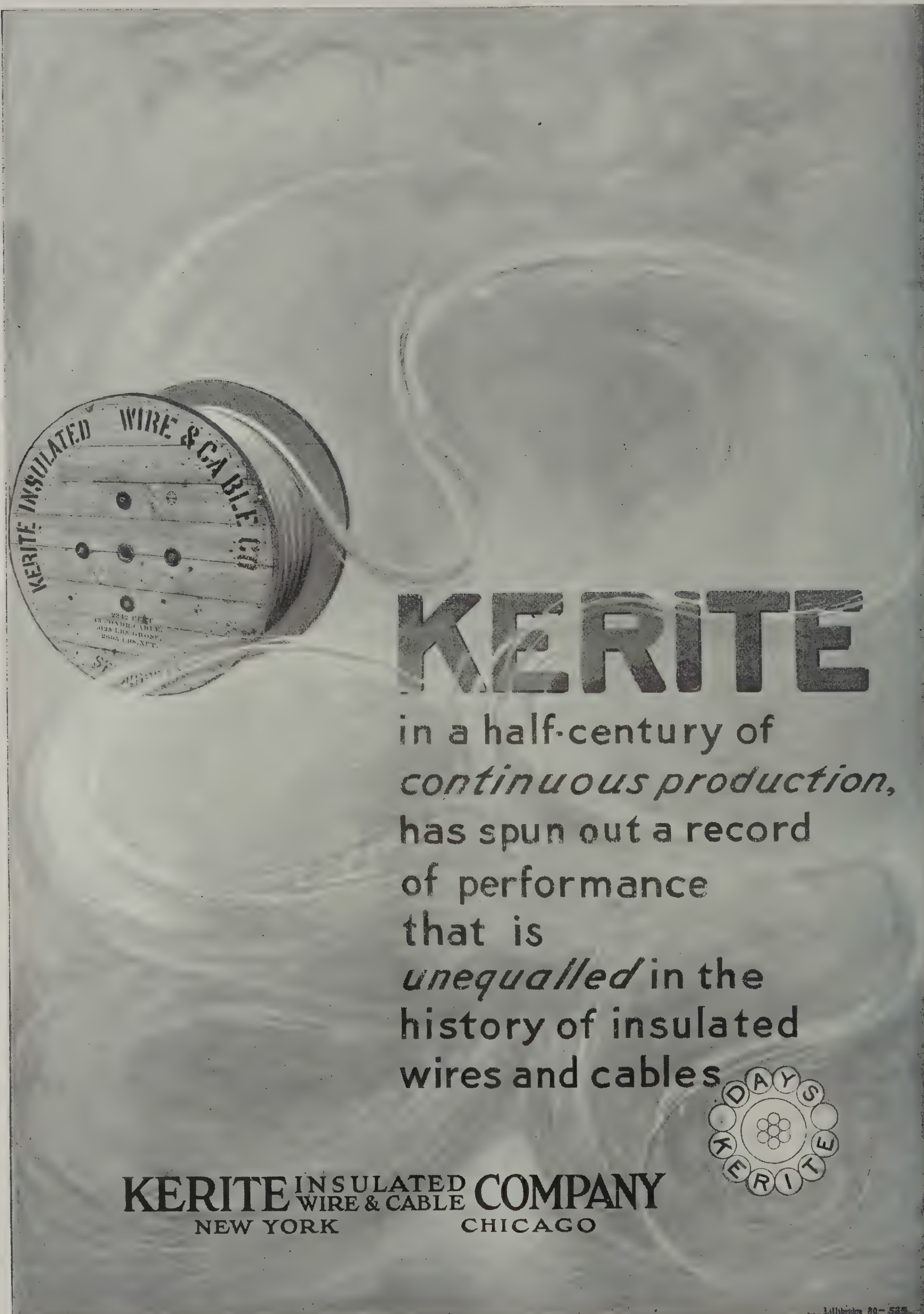
Low cost per car per month

These service advantages are worth paying a premium to obtain. Yet, on the contrary, many roads find that the cost per car per month of the Exide reaches a new low level.

This level is low enough to interest any car-lighting man. Have an Exide representative tell you in detail all that we have summarized here. A brief request, mailed to us today, will bring him.

THE ELECTRIC STORAGE BATTERY COMPANY
Philadelphia
Branches in Seventeen Cities
Manufactured in Canada by Exide Batteries of Canada, Limited, 133-157 Dufferin St., Toronto

Exide
BATTERIES

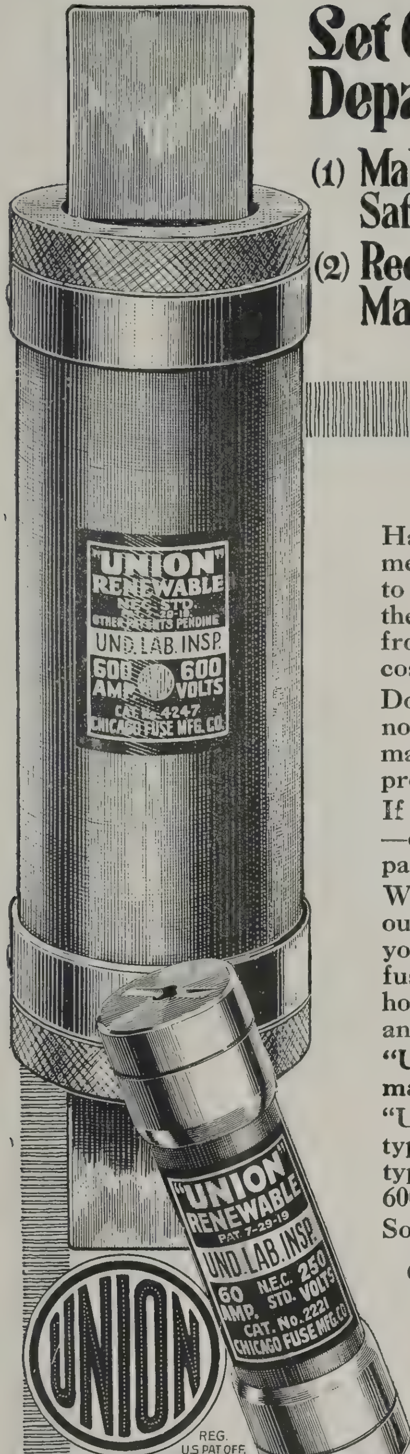


KERITE INSULATED WIRE & CABLE CO
KERITE
in a half-century of
continuous production,
has spun out a record
of performance
that is
unequalled in the
history of insulated
wires and cables
DAYS KERITE
KERITE INSULATED WIRE & CABLE COMPANY
NEW YORK CHICAGO

Let Our Service Department Help You

(1) Make Sure of the Safety of Each Circuit

(2) Reduce Your Fuse Maintenance Cost



Have you ever had the fusing requirements of your plant thoroughly analyzed to make sure that you are using exactly the right kind of fuse on each circuit from the standpoint of protection and safety as well as yearly cost?

Do you realize how the wrong type of fuse in any given circuit not only adds greatly to your fuse expense but also endangers the machinery on that circuit—is perhaps even a menace to life and property?

If you have any doubt about the fusing in any part of your plant —either from the standpoint of safety or cost—our Service Department can be of very practical help to you.

Without any expense or obligation whatever on your part, one of our Fuse Engineers—either independently or in co-operation with your own Engineer—will gladly make a careful survey of the fusing requirements throughout your plant, and then point out how and where and why your yearly fuse costs can be reduced and the safety and efficiency of your plant increased.

"Union" Renewable Fuses effect the greatest reduction in fuse maintenance cost.

"Union" Fuses are made in both Renewable and Non-Renewable types. The National Board of Fire Underwriters have given both types their very highest approval in all capacities, both 250 and 600 volt.

Sold by leading electrical jobbers and dealers.

Our new 96-page catalog contains many important fuse facts. Free on request.

CHICAGO FUSE MFG. CO.

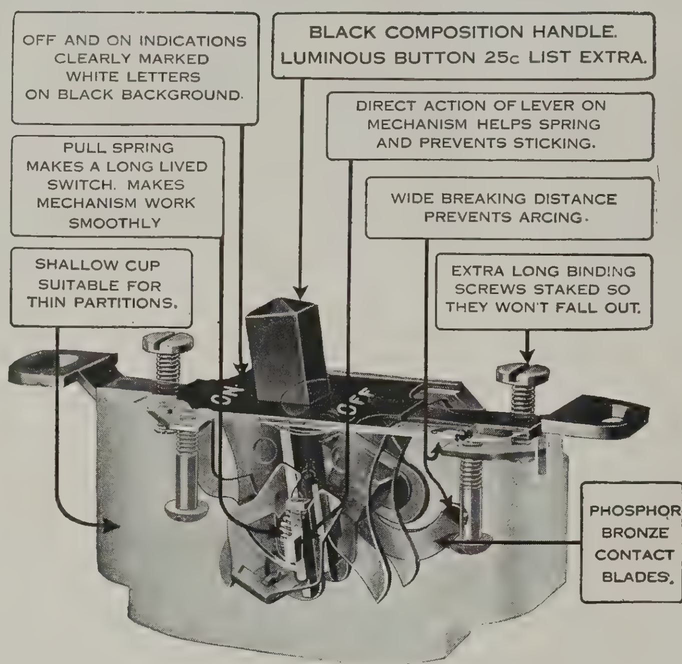
Manufacturers of Switch Boxes, Cut-Out Bases, Fuse Plugs, Automobile Fuses, Renewable and Non-Renewable Enclosed Fuses

CHICAGO NEW YORK

UNION REG. U.S. PAT. OFF.

'UNION' FUSES
RENEWABLE & NON-RENEWABLE

The BRYANT positive acting flush toggle switch always works



See that little cam on the operating lever? When you push the lever it pushes on the rocker. The rocker has to move. It can't hang up.

That's why it is called the positive acting switch.

Now being delivered in single pole, double pole, and three point styles, with plates for all purposes.

SHALLOW FLUSH TOGGLE SWITCHES, BLACK COMPOSITION HANDLES

Porcelain Cups — **Composition Cups**

List No.	List Price	Std. Pkge.	Carton	Schedule	Description	Amperes 125 Volts	Amperes 250 Volts	Carton	Std. Pkge.	List Price	List No.
2951	$0.45	100	10	H 2	* Single pole, indicating	10	5	10	50	$0.72	2961
2952	.70	50	10	H 2	* Double pole, indicating	10	10	10	10	.88	2962
2953	.70	50	10	H 2	* Three point	10	5	10	20	.88	2963
2954	2.00	10	10	H 2	* Four point	10	5	10	10	2.00	2964
2955	1.00	10	10	H 2	* Double pole, indicating	20	20	10	10	1.40	2965

TOGGLE SWITCH FLUSH PLATES—ONE HORIZONTAL ROW ONLY

Struck-up (.040 inch Brass) — **Solid Brass (.110 inch Brass)**

List No.	List Price	Std. Pkge.	Carton	Schedule	Description	Dimensions, In. Vert.	Dimensions, In. Horiz.	List Price	List No.
3681	$0.14	100	25	H 3	* For One Switch	4½	2¾	$0.34	3691
3682	.28	50	10	H 3	* For Two Switches	4½	4 9/16	.68	3692
3683	.42	35	5	H 3	* For Three Switches	4½	6⅜	1.02	3693
3684	.88	25	5	H 3	* For Four Switches	4½	8 3/16	1.36	3694
3685	1.10	20	5	H 3	* For Five Switches	4½	10	2.00	3695
3686	1.32	20	1	H 3	* For Six Switches	4½	11 13/16	2.40	3696
3687	1.54	15	1	H 3	* For Seven Switches	4½	13⅝	2.80	3697
3688	1.76	15	1	H 3	* For Eight Switches	4½	15 7/16	3.20	3698

Any of these plates can be supplied with "Perma" finish for **$0.04** list per gang less than the list price of the same plate with brush brass finish.

* National Electrical Code Standard.

THE BRYANT ELECTRIC COMPANY

BRIDGEPORT, CONNECTICUT

New York
342 Madison Ave.

Chicago
844 West Adams St.

San Francisco
149 New Montgomery St.

Phono-Electric

—The Answer to Why, is WEAR!

"What a true line," any line engineer will say on examining the overhead work of the Pennsylvania's 11,000-volt Philadelphia-Paoli electrification.

And it will stay true for years to come, despite the almost incessant pounding from the current collectors of high-speed trains, because Phono-Electric trolley wire is a contact wire that is stiff enough to stay in line and hard enough to take the wear.

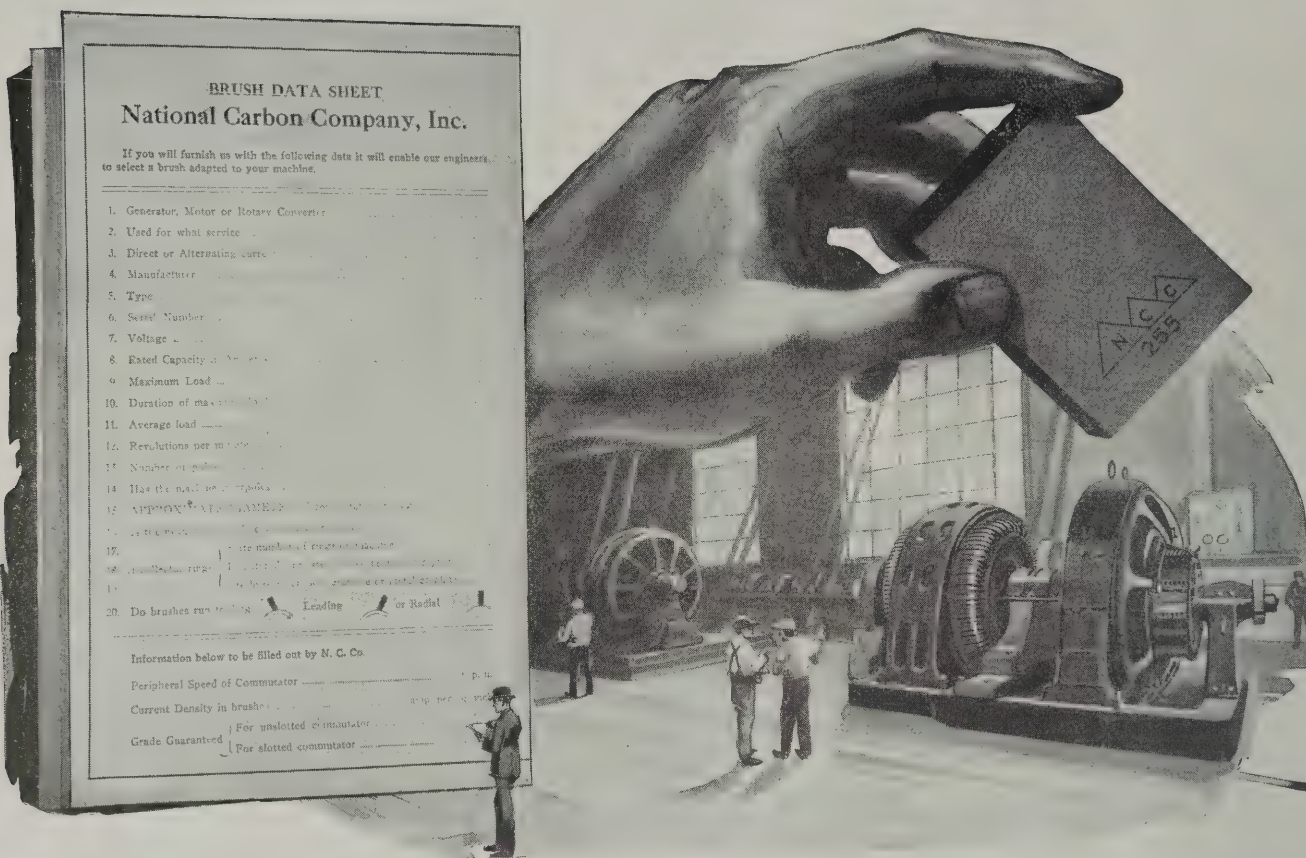
"Bridgeport" BRASS CO. TRADE MARK

MEMBER AMERICAN ELECTRIC RAILWAY ASSOCIATION AERA 1922

Bridgeport Brass Company

Bridgeport Connecticut

2014



Picking brushes for the job—

NATIONAL CARBON Data Sheet Service will assure correct brushes for each of your motors and generators. It is a service of investigation, analysis, and specification by National Carbon Brush Specialists. We guarantee to be satisfactory the brushes they specify.

Avail yourself of this service; fit each machine with the brushes best suited for your operating conditions. The service is at your command, whether you have one unit or a thousand.

National Carbon Data Sheet Service solves your brush problems Write the address below

N C C

NATIONAL CARBON COMPANY
Incorporated
CLEVELAND, OHIO SAN FRANCISCO, CALIF.
Canadian National Carbon Co., Limited, Toronto

Hair pin curves and straightaways one and the same to Goodrich Belts

THERE is no creeping over the pulley flanges with a Goodrich Axle Lighting Belt when the coach rounds a sharp curve. No undue strains. No undue wear. Goodrich Axle Lighting Belt has a crosswise rigidity that enables the belt to keep its proper course on a curve as easily as on the straightaway. This rigidity plus longitudinal flexibility and strength are two reasons why Goodrich Axle Lighting Belts last longer and save railroads money.

THE B. F. GOODRICH RUBBER COMPANY
Akron, Ohio

Goodrich

AXLE LIGHTING BELTS

"Best in the Long Run"

National Products

"All you require—When you Wire"

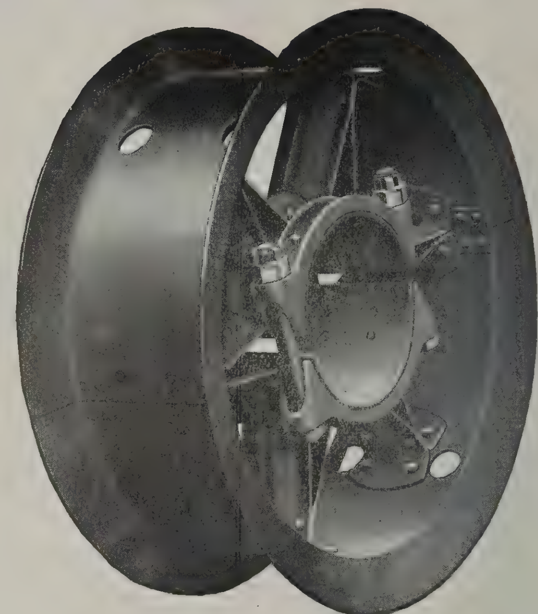
The National Line includes everything for interior wiring—right to the point of service. It is the one complete line of wiring materials.

NATIONAL PRODUCTS
N M M C

National Metal Molding Co.

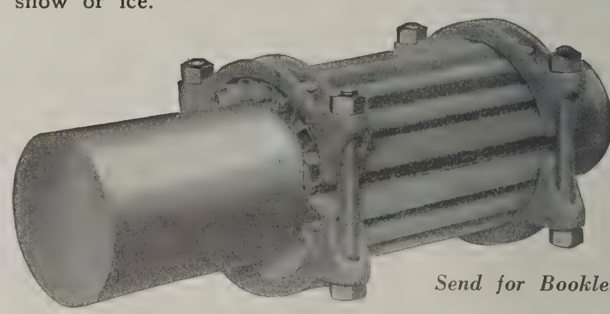
PITTSBURGH, PA.

OFFICES IN ALL PRINCIPAL CITIES



The Master Car Builder's Logical Choice is the KEYSTONE Steel Car Lighting Pulley

Provided with re-inforced hub and arms set lengthwise to strain. Metals are countersunk to prevent shearing strain on rivets. Adapted for severe service and will operate efficiently regardless of jolts, vibration, rain, snow or ice.



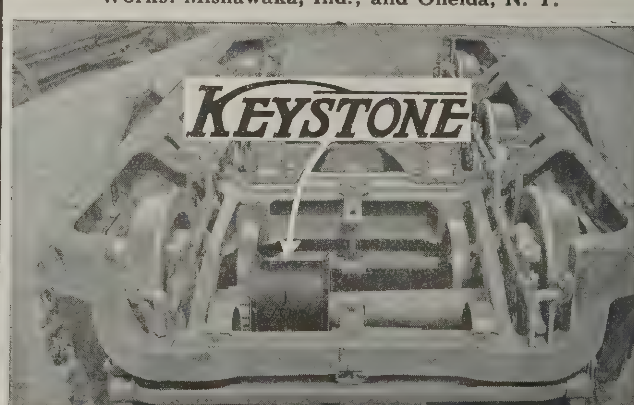
Send for Booklet

ONEIDA Corrugated Bushing

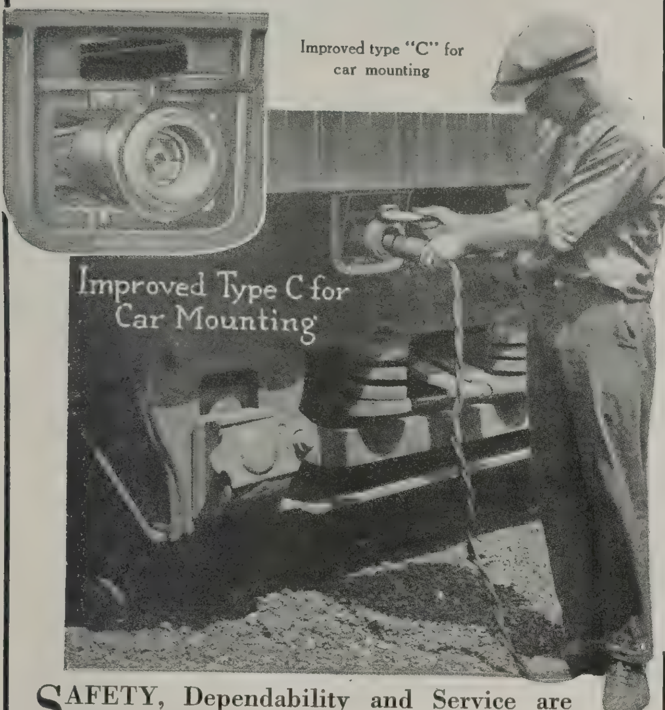
For straight or tapered axles. Grips the shaft firmly—requires no machining and only 1/4″ clearance between car axle and pulley bore.

Dodge Sales and Engineering Co.

General Offices: Mishawaka, Ind.
Works: Mishawaka, Ind.; and Oneida, N. Y.



SAFE-DEPENDABLE SERVICE



SAFETY, Dependability and Service are three big factors bringing about the great satisfaction obtained by the use of

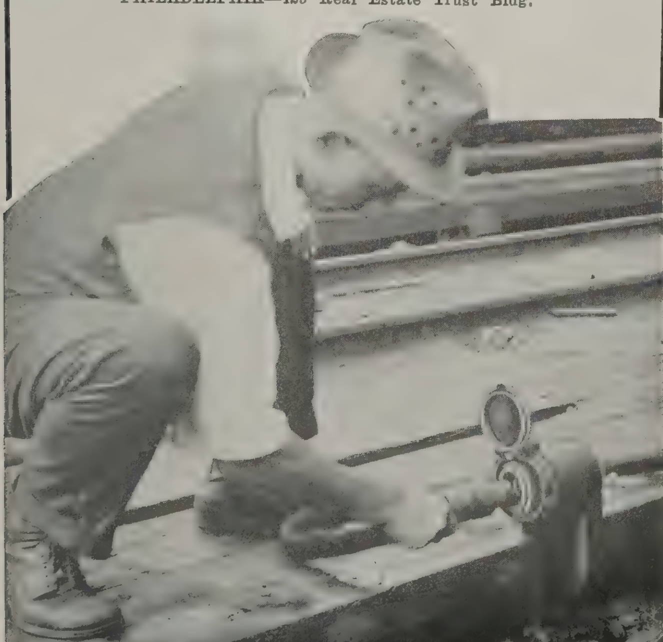
Anderson Charging Plugs and Receptacles

The Anderson line conforms to A. R. E. E. Standards, and M. C. B. specifications—and is standard on most large railroad systems.

There is an Anderson type for every special requirement.
Write our nearest office for complete information.

Albert & J. M. Anderson Mfg. Co.
289 A Street, Boston, Mass.

NEW YORK—135 Broadway CHICAGO—105 S. Dearborn St.
PHILADELPHIA—429 Real Estate Trust Bldg.



Why Not Break the "Lead-Lining" Habit?

There are some mighty good battery men who have been buying batteries so long that they write "lead-linings" into the specifications just as a matter of course.

Yet there's no getting around the fact that rubber jars are money savers any way you figure. They put an end to the leakage between battery elements and steel battery boxes—they are not affected either by acid or electrolysis—they're extra strong to stand the everyday bumps and the handling on and off the car. Willard Rubber Battery Jars are made of *all new* live rubber, testing 5,000 pounds tensile strength, and 15% elongation.

There are so many advantages in Willard Rubber Jars that when the lead-lining habit is once broken in their favor, there's no temptation to slide back into it.

Willard Storage Battery Company
Cleveland, Ohio

Willard STORAGE BATTERY

Salamander

All asbestos locomotive headlight wire and cab cord

Locomotive headlight wire single conductor, solid or stranded wires as ordered, special compound treatment to secure maximum resistance to moisture.

Cab cord, two conductor all asbestos.

YORK INSULATED WIRE WORKS

of General Electric Co.

Works: York, Pa. 1737 Broadway, N. Y. City

Eliminating a Weak Link

A chain is no stronger than its weakest link, and the weakest links in an underground cable system are apt to be the joints unless the latter are made with the greatest care.

STANDARD Jointing Materials

(Paper Jointing Tubes, "Ozite" Insulating Compounds, etc.)

make possible the practical elimination of these weak links even with working pressures as high as 27,000 volts.

If you are interested in eliminating joint troubles, write for Bulletin No. 740.

Standard Underground Cable Co.

Boston, New York, Philadelphia, Pittsburgh, Washington, Atlanta, Chicago, Detroit, St. Louis, Kansas City, Seattle, Los Angeles, San Francisco

For Canada: Standard Underground Cable Co. of Canada, Limited, Hamilton, Ont.

Strange names to you
The day's work to us

Rail Bonds, Trolley Material, High Tension Insulators—these are nothing more than strange names in the purchasing office of a purely steam railroad. But they are the study, the work, the bread-and-butter of the O-B Organization and have been for years.

When a steam road electrifies a section it finds the O-B Organization ready to simplify its problem insofar as the transmission, distribution and collection of power is concerned. Specialists, who have the benefit of first-hand contact with most of the existing electrifications, work with the railroad's organization and specify or originate the best materials for the work to be done.

The Ohio Brass Company
Mansfield Ohio, U. S. A.

Valley Buffers Simplify Shop Service

Valley Buffers are equipped with standard Valley Motor parts. They are:

Rugged
Ball-Bearing
Durable
Simple

Get one for your shop.

Price $106.00

2 h. p. 60 Cycle, Two or Three Phase. Made in sizes from 1-2 h. p. up. Single Phase and 2 or 3 Phase. Prices Accordingly.

Valley Electric Co.
3157 S. Kingshighway, ST. LOUIS, MO.

Valley Buffers

Buying the Seen and the Unseen

It is easy to judge the size and quality of a visible commodity. There are certain recognized standards that have been universally accepted to which purchased articles may be compared.

With invisible commodities, such as a publication's circulation, the matter is not so simple. It was only recently that a definite measurement has been obtained.

The A. B. C. now furnishes a recognized standard by which circulation may be measured. A publication's distribution can now be as accurately gauged as any other purchased commodity.

The *Railway Electrical Engineer's* circulation is measured by the A. B. C. In buying advertising space in its columns, you receive dollar-for-dollar value.

Simmons-Boardman Pub. Co.
"The House of Transportation"
New York, Philadelphia, Cleveland, Washington, D. C., Chicago, Cincinnati, London, Eng.

The cars of the Chicago Elevated Railways are Unilet equipped.

For Unfailing Service

Wherever electrical wiring must give the utmost in service—where the conditions are the most severe—Unilets have an enviable reputation.

Their light weight due to the pressed steel construction makes handling easier, more rapid, and less costly.

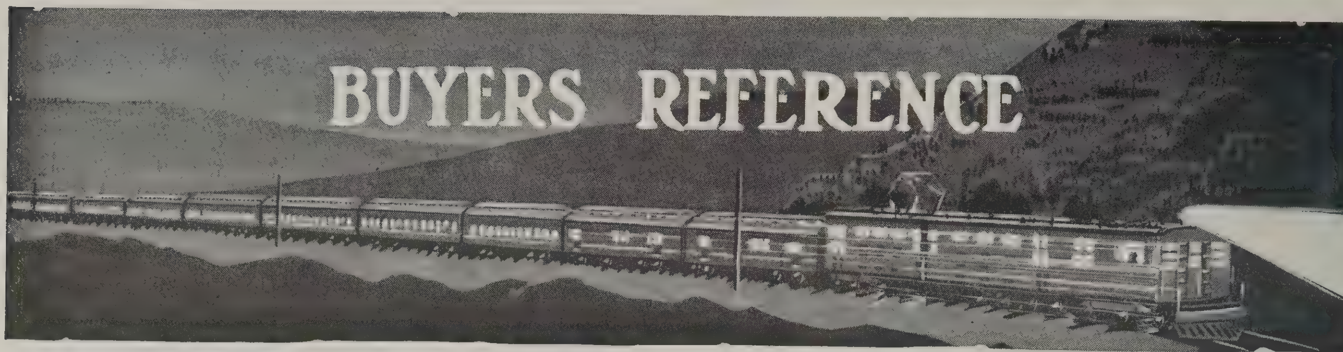
This construction also facilitates wiring because of the increased space with no increase in the dimension of the fitting.

There is an Appleton Unilet for every requirement

APPLETON ELECTRIC COMPANY
Factory and General Offices
1706 Wellington Avenue at Paulina
Chicago

Unilets, Uniduct, Outlet Boxes and Covers, Laundry Fittings, Locknuts and Bushings, Meter Terminal Fittings, Entrance Fittings, Conduit Clamps and Hangers, Switch Boxes, Reelites and Autoreelites.

"UNILETS"
REG. U.S. PAT. OFF.



A. C. Floating Battery System
Valley Electric Co.

Arc Welding Equipment
General Electric Co.
Westinghouse Electric & Mfg. Co.

Adjusters, Lamp Cord
Appleton Electric Co.

Arrestors, Lightning
General Electric Co.
Westinghouse Electric & Mfg. Co.

Axle Pulleys
Dodge Sales & Engineering Co.
Electric Storage Battery Co.
Safety Car Heating & Lighting Co.
Stone Franklin Co.

Axle Pulley Bushings
Dodge Sales & Engineering Co.
Electric Storage Battery Co.
Safety Car Heating & Lighting Co.
Stone Franklin Co.

Batteries, Dry
National Carbon Co.

Batteries, Storage
Edison Storage Battery Co.
Electric Storage Battery Co.
Safety Car Heating & Lighting Co.
Western Electric Co.
Willard Storage Battery Co.

Battery Charging Apparatus
Anderson Mfg. Co., Albert & J. M.
Electric Storage Battery Co.
Safety Car Heating & Lighting Co.
Stone Franklin Co.
Valley Electric Co.
Westinghouse Electric & Mfg. Co.

Bearings, Axle Generator
Electric Storage Battery Co.
Oliver Electric & Mfg. Co.
S. K. F. Industries, Inc.
Safety Car Heating & Lighting Co.
Stone Franklin Co.

Bearings, Ball
S. K. F. Industries, Inc.

Bearings, Ball Thrust
S. K. F. Industries, Inc.

Belting, Axle Generator
Goodrich Rubber Co., B. F.

Bonds, Rail
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.

Boxes, Fuse
Appleton Electric Co.
Central Electric Co.
Chicago Fuse Mfg. Co.

Boxes, Junction and Outlet
Appleton Electric Co.
Central Electric Co.
Chicago Fuse Mfg. Co.
Standard Underground & Cable Co.

Boxes, Subway
Johns-Pratt Co., The

Boxes, Switch
Appleton Electric Co.
Central Electric Co.
Chicago Fuse Mfg. Co.
Electric Controller & Mfg. Co.
Johns-Pratt Co., The

Brakes, Crane
Electric Controller & Mfg. Co.

Brakes, Disc
Electric Controller & Mfg. Co.

Brakes, Electric
Electric Controller & Mfg. Co.
General Electric Co.
Westinghouse Elec. & Mfg. Co.

Brush Holders
Anderson Mfg. Co., Albert & J. M.

Brushes, Generator
Electric Storage Battery Co.
National Carbon Co.
Safety Car Heating & Lighting Co.
Stone Franklin Co.

Buffers
Valley Electric Co.

Cable, Armored and Lead Covered
Central Electric Co.
General Electric Co.
Hazard Mfg. Co.
Kerite Insulated Wire & Cable Co.
Standard Underground Cable Co.
York Insulated Wire Works.

Cable, Insulated
Central Electric Co.
General Electric Co.
Goodrich Rubber Co., B. F.
Hazard Mfg Co.
Kerite Insulated Wire & Cable Co.
Standard Underground Cable Co.
York Insulated Wire Works.

Cable, Telephone
Central Electric Co.

Car Lighting Equipment
Electric Storage Battery Co., The
Oliver Electric & Mfg. Co.
Safety Car Heating & Lighting Co.
Stone Franklin Co.

Caustic Soda Cells
National Carbon Co.

Circuit Breakers, Carbon
General Electric Co.

Circuit Breakers, Oil
General Electric Co.
Westinghouse Electric & Mfg. Co.

Clamps and Connectors
Anderson Mfg. Co., Albert & J. M.
General Electric Co.

Cleats
National Metal Molding Co.

Compressors, Air
General Electric Co.
Westinghouse Electric & Mfg. Co.

Conduit Fittings
Appleton Electric Co.
Central Electric Co.
Chicago Fuse Mfg. Co.
Electric Controller & Mfg. Co.

Conduit, Flexible Metallic
Central Electric Co.
Electric Storage Battery Co.
National Metal Molding Co.

Conduit, Rigid
Central Electric Co.
Electric Controller & Mfg. Co.
National Metal Molding Co.

Control Apparatus, Car Lighting
Electric Storage Battery Co.
Safety Car Heating & Lighting Co.
Stone Franklin Co.
Westinghouse Electric & Mfg. Co.

Controllers, Automatic
Electric Controller & Mfg. Co.
General Electric Co.
Westinghouse Electric & Mfg. Co.

Controllers, Crane
Electric Controller & Mfg. Co.
General Electric Co.

Controllers, Manual
Electric Controller & Mfg. Co.
General Electric Co.

Controllers, Machine Tool
Electric Controller & Mfg. Co.
General Electric Co.

Copper Rods and Tubes
Standard Underground Cable Co.

Cutouts, Entrance
Appleton Electric Co.
Chicago Fuse Mfg. Co.
Johns-Pratt Co., The

Electrical Apparatus and Supplies
Bryant Electric Co., The
Central Electric Co.
General Electric Co.
Westinghouse Electric & Mfg. Co.

Electrification Construction Materials
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.

Electrification of Steam Roads
General Electric Co.
Westinghouse Electric & Mfg. Co.

Electrode
National Carbon Co.

Fans, Car
Central Electric Co.
General Electric Co.
Safety Car Heating & Lighting Co.
Westinghouse Electric & Mfg. Co.

Fans, Desk and Bracket
Central Electric Co.
General Electric Co.
Westinghouse Electric & Mfg. Co.

Fixtures, Car Lighting
Central Electric Co.
Oliver Elec. & Mfg. Co.
Safety Car Heating & Lighting Co.

Fixtures, Locomotive Cab Lighting
Central Electric Co.
Oliver Electric & Mfg. Co.

Fixtures, Office, Shop and Yard Lighting
Central Electric Co.
Oliver Electric & Mfg. Co.
Westinghouse Elec. & Mfg. Co.

Flashlights
National Carbon Co.

Floodlights
Central Electric Co.
General Electric Co.

Fuses, Cartridge
Central Electric Co.
Chicago Fuse Mfg. Co.
General Electric Co.
Johns-Pratt Co., The

Fuses, High Voltage
Johns-Pratt Co., The

Fuses, Plug
Central Electric Co.
Chicago Fuse Mfg. Co.

Fuses, Refillable
Central Electric Co.
Chicago Fuse Mfg. Co.
General Electric Co.
Johns-Pratt Co., The

Fuses, Non-Refillable
Johns-Pratt Co., The

Generators, Axle Driven
Electric Storage Battery Co.
Safety Car Heating & Lighting Co.
Stone Franklin Co.

Generators, Car Lighting
Electric Storage Battery Co.
Safety Car Heating & Lighting Co.
Stone Franklin Co.

Generators, Power and Lighting.
General Electric Co.
Westinghouse Electric & Mfg. Co.

Hangers, Catenary
Ohio Brass Co.

Headlight Reflectors and Cases
General Electric Co.
Sunbeam Electric Mfg. Co.

Headlight Turbo Generators
General Electric Co.
Sunbeam Electric Mfg. Co.

Headlights, Locomotive
Sunbeam Electric Mfg. Co.

Hose.
Goodrich Rubber Co., B. F.

Insulating Compounds
General Electric Co.
Standard Underground Cable Co.
Westinghouse Electric & Mfg. Co.

Insulating Materials
Central Electric Co.
General Electric Co.
Westinghouse Electric & Mfg. Co.

Insulators
Ohio Brass Co.

Insulators, Catenary
Ohio Brass Co.

Insulators, Third Rail
Ohio Brass Co.

Lamp Guards
Appleton Electric Co.
General Electric Co.

Lamps, Gauge
Central Electric Co.
Oliver Electric & Mfg. Co.

Lamps, Incandescent
Central Electric Co.

Lighting Units, Indoor and Outdoor
Central Electric Co.
Westinghouse Elect. & Mfg. Co.

Lifting Magnets
Electric Controller & Mfg. Co.

Line Material
Bridgeport Brass Co.
Central Electric Co.
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.

Locomotives, Electric
General Electric Co.
Westinghouse Electric & Mfg. Co.

Magnetizers
Valley Electric Co.

Mechanical Rubber Goods
Goodridge Rubber Co., B. F.

Motors, A. C.
Fairbanks, Morse & Co.
General Electric Co.
Valley Electric Co.
Westinghouse Electric & Mfg. Co.

Motors, D. C.
Electric Controller & Mfg. Co.
Fairbanks, Morse & Co.
General Electric Co.
Valley Electric Co.
Westinghouse Electric & Mfg. Co.

Motor Generator Sets
Electric Controller & Mfg. Co.
General Electric Co.
Valley Electric Co.
Westinghouse Electric & Mfg. Co.

Motor and Generator Brushes
National Carbon Co.

Motor Cars, Gas-Electric
Fairbanks, Morse & Co.
General Electric Co.

Motor Starters and Controllers
Anderson Mfg. Co., A. & J. M.
Electric Controller & Mfg. Co.
General Electric Co.
Westinghouse Electric & Mfg. Co.

Saves its Cost

within Six Months to a year

by Cutting Polishing Expense

Retains its Polish Like an Automobile Headlight

HEADLIGHTS SUNBEAM TURBO-GENERATORS

America's Foremost Headlight Builders for 30 Years

The great expense of keeping headlight reflectors cleaned and polished and the cost of frequent replating has been reduced to a trifle in this new creation of our engineers. It is the result of exhaustive study and experimenting and our many years of experience in making headlights.

These headlights show more than one million (1,000,000) candlepower on photometric tests.

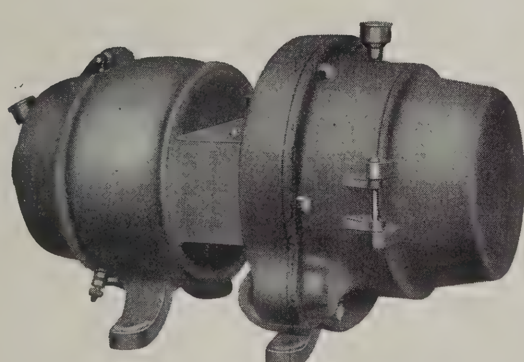
Non Tarnishing—Dust Proof

The silverplated copper reflector of this headlight is non-tarnishing. The reflecting surface needs polishing but once a year. Need be replated only once in five to seven years. The style of mounting supporting the reflector in the goggle around the entire frame, prevents sagging.

Case Lasts as Long as Locomotive

The case of this headlight is made of 16 gauge iron protected with baked automobile fender enamel. It is comparatively light in weight and can be removed by one man. Burned-out lamps easily replaced thru apex of reflector. Has universal focusing device, adjusted with one hand.

An ideal headlight at a reasonable price.



Sunbeam Turbo-Generator
Type RE-3—500 Watts—32 Volts.

Write for bulletin No. 107, giving complete description and particulars.

SUNBEAM ELECTRIC MANUFACTURING CO.

(Formerly Schroeder Headlight and Generator Co.)

EVANSVILLE INDIANA U. S. A.

NEW YORK	RICHMOND, VA.	CHICAGO	SAN FRANCISCO
52 Vanderbilt Ave.	Broadway National Bank Bldg.	1051 McCormick Bldg.	507 New Call Bldg.

BUYERS REFERENCE

ALPHABETICAL INDEX

3-Conductor Hazard Spiralweave Power Cable.

HAZARD

SPIRALWEAVE

CABLE

Ruggedly built "Firehose" type Cables for the hardest kind of work. The rubber insulation is the highest quality made, the covering is extra heavy, woven (not "braided") tightly around the core,—tough, strong, wear-resisting and thoroughly weatherproofed.

Just the thing for CHARGING BATTERIES, for PORTABLE LIGHTS, ELECTRIC DRILLS, ROUNDHOUSE WIRING, or wherever a strong, long wearing cord or cable is needed.

3-Conductor HAZARD Steel Tape Armored Power Cable

HAZARD STEEL TAPE ARMORED CABLE with lead sheath, double layer of flat steel armor and asphalted jute covering, offers a means of placing power circuits underground without conduits.

Consider the advantage of having your power cables safely underground, away from storm hazards and winter ice and snow.

Eliminate the expense of poles, crossarms and insulators, and high cost of maintenance, to say nothing of the unsightliness and obstruction of pole lines.

To be laid 18 to 24 inches under the surface, no other protection necessary.

The cost is less and the safety greater.

Hazard Spiralweave Cord.

Hazard Manufacturing Company

Wilkes-Barre, Penna.

New York Pittsburgh Chicago Denver Birmingham

HAZARD WIRES

Hazard

RUBBER INSULATED WIRES & CABLES

HAZARD WIRES

SKF

Ball Bearing Axle Generators

In Service Over Eight Years

EIGHT and a quarter years of service, corresponding to over 600,000 car miles have been obtained from deep-groove ball bearings made by the Hess-Bright Manufacturing Company, on axle generators. Furthermore, inspection shows that the bearings are still capable of operating satisfactorily for a long period.

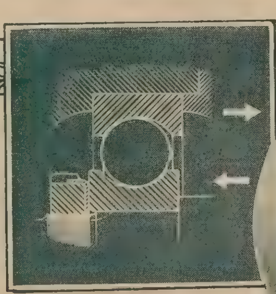
And when it is remembered that ball bearings require no renewals and need lubricating only at infrequent intervals, one can readily appreciate why ball bearings are considered as standard equipment for axle generators by most railroads.

The ability of ball bearings to keep rotating parts permanently in their original settings, their cleanliness, their freedom from lubrication troubles and their power saving features are responsible for this performance. These same advantages accompany the use of ball bearings in all classes of service and makes them especially well adapted to railway shop equipment where reliability, economy and readiness for service are of paramount importance.

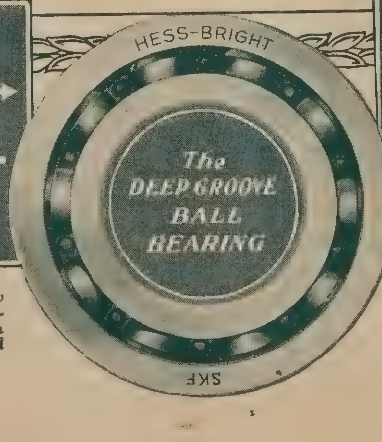
THE HESS-BRIGHT MANUFACTURING COMPANY

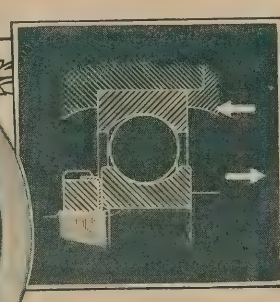
Supervised by SKF INDUSTRIES, INC., 165 Broadway, New York City

867



Races displaced to show DEEP-GROOVE bearing carrying maximum end thrust in a forward direction.





Races displaced to show THE SAME bearing carrying maximum thrust in reverse direction.

BALL BEARINGS

The Highest Expression of the Bearing Principle

UNIVERSITY OF ILLINOIS-URBANA
3 0112 066918779